RAILROAD AND ENGINEERING JOURNAL

NEW YORK [ETC.]

V. 61, 1887

(Established 1832.)

THE RAILROAD AND ENGINEERING JOURNAL.

The AMERICAN RAILROAD JOURNAL and VAN NOSTRAND'S ENGINEERING MAGAZINE
have been consolidated in this publication.

VOLUME LXI.

[VOLUME I, NEW SERIES.]

1887.

Published Monthly at 45 Broadway, New York, by

M. N. FORNEY.

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[VOLUME I, NEW SERIES.]

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THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 23 MURRAY STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, JANUARY, 1887.

PREFACE.

A PUBLIC announcement was made some months ago, that the AMERICAN RAILROAD JOURNAL and *Van Nostrand's Engineering Magazine* had been sold to me, and that the two would be consolidated on January 1st, 1887, under my editorial management. The title for the combined publication instead of being the AMERICAN ENGINEERING MAGAZINE AND RAILROAD JOURNAL, as was first announced, will be THE RAILROAD AND ENGINEERING JOURNAL, which will be devoted to the discussion of engineering and mechanical subjects. Railroad construction and operation being, however, the most important branches of engineering in this country, more space will be devoted to them than to any other one department of engineering. Questions of traffic and finance will not be taken up, excepting so far as they are incidentally concerned with engineering matters.

The JOURNAL, in its new form, will be an illustrated monthly publication, having more the character of a magazine than of a trade journal. The editor will aim to maintain the high character of *Van Nostrand's Engineering Magazine*, but some changes will be made to adapt its successor to a somewhat wider field, which its new proprietor hopes to be able to occupy. An editorial and news department will be added, more engravings will be given, and especial effort will be made to have the typography and printing of both the reading matter and advertisements, and the mechanical work generally, of the best kind. It is intended that, eventually, a larger proportion of original matter will be given in the JOURNAL than has heretofore been published in *Van Nostrand's Engineering Magazine*, but some time will be required to secure contributors and correspondents, so that in the beginning the JOURNAL will contain a considerable proportion of selected articles.

It is impossible, though, to indicate in advance precisely the character which the JOURNAL will assume. Its editor will aim to adapt it to the wants and demands of its readers, and to make it what its title implies—a first-class railroad and engineering journal. Its future numbers will determine its value to its readers, whose verdict, which will be recorded in its subscription list, is awaited with much interest.

Mr. FREDERICK HOBART, who for more than ten years was associated with me in editorial work, will, after January 1st, assist me in conducting this JOURNAL.

M. N. FORNEY.

NEW YORK, January 1st, 1887.

OUR PROGENITORS.

AS THE RAILROAD AND ENGINEERING JOURNAL is the result of a consolidation of two publications, its advent seems to demand some account of its lineage. Without other prelude then, the history of the oldest of its two ancestors—the AMERICAN RAILROAD JOURNAL—may begin with the announcement of its birth. This was on January 2d, 1832. It is, therefore, the oldest railroad paper in the world. *Herapath's Railway Journal*, in England, which is probably the next oldest, was established in 1835 as the *Railway Magazine*.

It has been announced for years past, on the title page, and elsewhere, in the AMERICAN RAILROAD JOURNAL, that it was established in 1831. This was due to the fact that the first number of the JOURNAL in the office file is dated January 2d, 1831, whereas another copy of this number is dated 1832. As the succeeding numbers in the file are all dated 1832, it shows that the printer fell into the common error of not changing the date with the new year. The mistake was, however, discovered and corrected before the whole of the edition was printed.

The following is the announcement made in the first number:

AMERICAN RAILROAD JOURNAL.

The subscriber proposes to publish a weekly journal, commencing about the first of January, ensuing, to be called the AMERICAN RAILROAD JOURNAL. A principal object in offering the proposed work to the public, is to diffuse a more general knowledge of this important mode of internal communication, which, at this time, appears to engage the attention of almost every section of our country.

The AMERICAN RAILROAD JOURNAL will be printed on a sheet of the largest size (mammoth), and put up in a convenient form for binding, each number to contain sixteen large octavo pages of *three* columns each. The selections, upon the subject of railroads and other works of internal improvement, will be from the best authors, both of Europe and America, and will be occasionally illustrated by engravings. A part of this journal will be devoted to the subject of internal improvement—giving a history of the first introduction of railroads into England, and their improvements to the present day. It will also notice the meetings, in different sections of the country, upon the subject of railroads. The remaining part of the paper will contain the Literary, Miscellaneous and News matter of the NEW YORK AMERICAN, *as prepared for that paper*, omitting *all political* subjects, except such as are of general interest.

The terms of the AMERICAN RAILROAD JOURNAL are THREE dollars per annum, *payable in advance;* and will not be sent without. Any person who will obtain eight subscribers, and remit the amount, shall have a copy gratis; and to companies of *ten* subscribers, who associate and remit twenty-five dollars, it will be sent for $2.50 each per annum. The JOURNAL will be sent for *any* length of time desired, if paid in advance. It will be published on *Saturdays*.

Letters upon the subject of the AMERICAN RAILROAD JOURNAL may be addressed, free of postage, to the publisher and part proprietor,

D. K. MINOR,
No. 35 Wall street, New York.

This was succeeded by the following address:

TO THE PUBLIC.

In offering the AMERICAN RAILROAD JOURNAL to the public at this time, when so much and such general interest is felt on the subject of railroads in different sections of the United States, no apology is deemed necessary. The importance of some other mode of internal communication in this country, where the canals and rivers are for about one-third of the year closed by frost, renders it highly desirable that a fair experiment should be made of the utility of railroads. Such experiments are now in progress in several States; and all information, therefore, upon the comparative value of railroads and canals, which may be generally diffused amongst the people, must be valuable, as it may prevent a premature and useless expenditure of capital upon works concerning which sufficient data for a correct judgment are not possessed. Further investigation may lead to the construction of new canals, of the value of which, for a part of the year, we are fully aware; or it may confirm the opinion, fast gaining ground in this country, that railroads will, in a great measure, supersede canals, and, therefore, hasten the construction of a few important lines, through those parts of the country where the amount of business will warrant the undertaking. It is the object of this journal to disseminate as extensively as possible, accurate statements, drawn from European publications, little known, and less read in this country; to record the observations and suggestions of gentlemen of experience in the construction and use of railroads here; and to afford the whole at so cheap a rate, as to be within the reach of every person taking an interest in the subject.

It is intended to give a concise history of the introduction of railroads into England (which appears to have been as early as between the years 1602 and 1649, in the vicinity of Newcastle-upon-Tyne), with the various improvements, down to the present time; and to trace their introduction into, and peculiar adaptation to the business and climate of this country. It will also be the aim of the publisher to show, what *he* thinks may be shown conclusively, that for practical purposes, railroads are far superior to any other mode of internal communication; and that they must, in a few years, entirely take the place of canals, where new works are to be constructed. "The great advantage of railways," says Tredgold, a writer upon the subject, "will consist in their affording the means of transporting *heavy* goods with speed and certainty; and, recollecting that railroads are in an unperfect state, while the united efforts of our civil engineers have been chiefly devoted to canals for about a century, we may confidently hope that there is scope for improvement; and we may fairly infer that for new works railroads will, in nine cases out of ten, be better adapted for public benefit than canals." Entertaining these views, and aware of the general movements making in different sections of the conntry, for the purpose of adopting measures for the construction of railroads, he is induced to believe that a publication more acceptable, at this time, to a large portion of the intelligent community, could not be offered; and to that class of readers he looks with confidence for a liberal patronage, meaning, as he does, to merit it by untiring zeal to serve them.

After this an article from Wood's "Treatise on Railroads," on the History and Progress of Railroads, is reprinted.

The second page contains a notice of a locomotive built by BURSOM & CO., of Philadelphia, which, it is said, "is as simple as a common cart or wheelbarrow," and "works complete, and justifies the belief that it will out-run the far-famed 'Rocket' and 'Novelty.'"

All publishers and most editors will sympathize with a notice on the same page, which is as follows:

"An apology may be due to those gentlemen to whom the first number of the RAILROAD JOURNAL is sent; if so, the publisher trusts that he will be permitted to apologize, at the *same time*, for respectfully requesting every gentleman who may receive it not only to subscribe *himself*, but to show it to his neighbors, that they may also subscribe, and remit the amount in advance."

This, be it remembered, was written fifty-five years ago. The language, therefore, of this appeal is not that of the present editor of THE RAILROAD AND ENGINEERING JOURNAL, but the sentiments which were so felicitously expressed by the founder of the JOURNAL, are in exact accordance with those of its present owner.

The original heading and two others which succeeded it have been reproduced, and are given on the next page. Of the first one it is said, editorially, in the first number that, "it represents the locomotive engine, the 'Novelty,' of Messrs. Braithwait & Ericsson (which competed for the prize of £500, offered by the Directors of the Liverpool & Manchester Railway Company, and which would probably have taken it, but for some trifling difficulty in the machinery), with a carriage for passengers, of sufficient size to accommodate eighteen inside."

Of the second heading, which appeared in the second number, it is said, "the cut at the head of this journal which, although not one of the late improved engines, gives a very correct idea of a locomotive engine with its *train* attached."

The third heading appeared in the first number of the JOURNAL for the year 1833. The editor says of it:

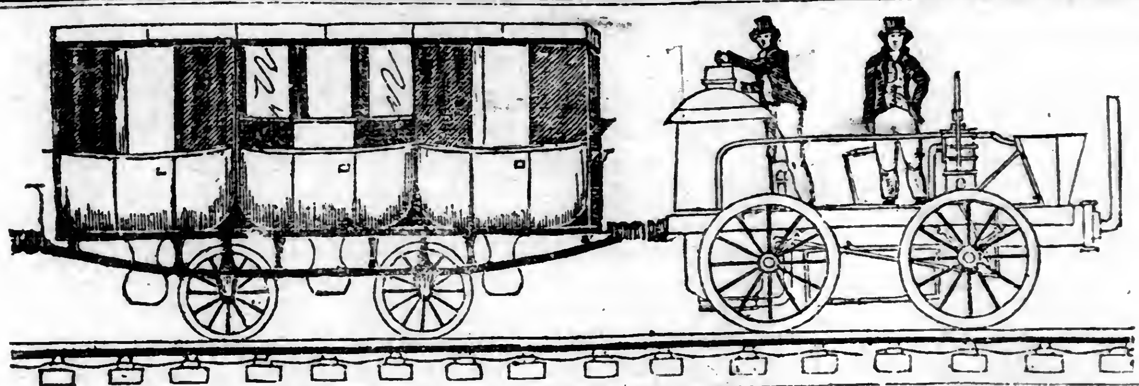
"The cut at the head of the JOURNAL represents the American locomotive engine 'Philadelphia,' built at the West Point Foundry Works, in this city, for the Philadelphia, Norristown & Germantown Railroad, with a freight car, passenger car, passenger coach and private carriage, attached, by way of showing the advantages and facilities which may be enjoyed by the inhabitants living in the vicinity of railroads."

The temptation to linger over these literally musty volumes—because they were in a building during a fire and most of them were soaked with water—is very great. It is proposed to publish in succeeding numbers of the JOURNAL a sort of retrospect of these early volumes, with copious notes and such extracts therefrom as will be interesting at the present day.

The JOURNAL, when first started, and for some years thereafter, was published weekly. Each number had sixteen pages, a little larger than those of the present publication. During its first two years it has a fairly prosperous appearance, but the first number for 1834 contains the announcement that the JOURNAL has not paid its expenses, and that the owner was obliged to advance over a thousand dollars to meet its ordinary expenses. In the first number of 1835, the editor says: "We hope for an increased number of patrons throughout the country. The latter we *must* and *are resolved* to have."

In the beginning of 1837 Mr. MINOR associated with himself Mr. GEORGE C. SCHAEFFER. In August the publication of the JOURNAL was suspended, and the September and subsequent numbers for that year did not appear until 1838. On July 1 of that year the *Mechanic's Magazine* was "united" with the RAILROAD JOURNAL, and the latter was changed to the form and size of an ordinary magazine, with the title of the AMERICAN RAILROAD JOURNAL AND MECHANICS' MAGAZINE. There is perhaps some significance in the fact that no name appears as editor or owner of the publication during the years 1838 and 1839. The June number for 1839 contains the announcement that Mr. MINOR had disposed of his interest in the JOURNAL to Mr. EGBERT HEDGE. He was associated with Mr. SCHAEFFER until the beginning of 1842, when Mr. HEDGE'S name disappears from the title page, that of Mr. SCHAEFFER remaining as editor. In the beginning of 1843 Mr. MINOR'S name again appears on the title page with that of Mr. SCHAEFFER as one of the editors and proprietors. In July, 1844, Mr. SCHAEFFER'S name disappears and that of Mr. MINOR alone remains as editor. In November of that year he announced that after the 1st of January, 1845, the JOURNAL would be issued weekly in its original quarto form of 16 pages. It was also said in this announcement that when the JOURNAL was originally started "the details of construction occupied the prominent place; whereas now, the *management* of railways, their *cost*, *income* and *dividends*, will especially receive our notice."

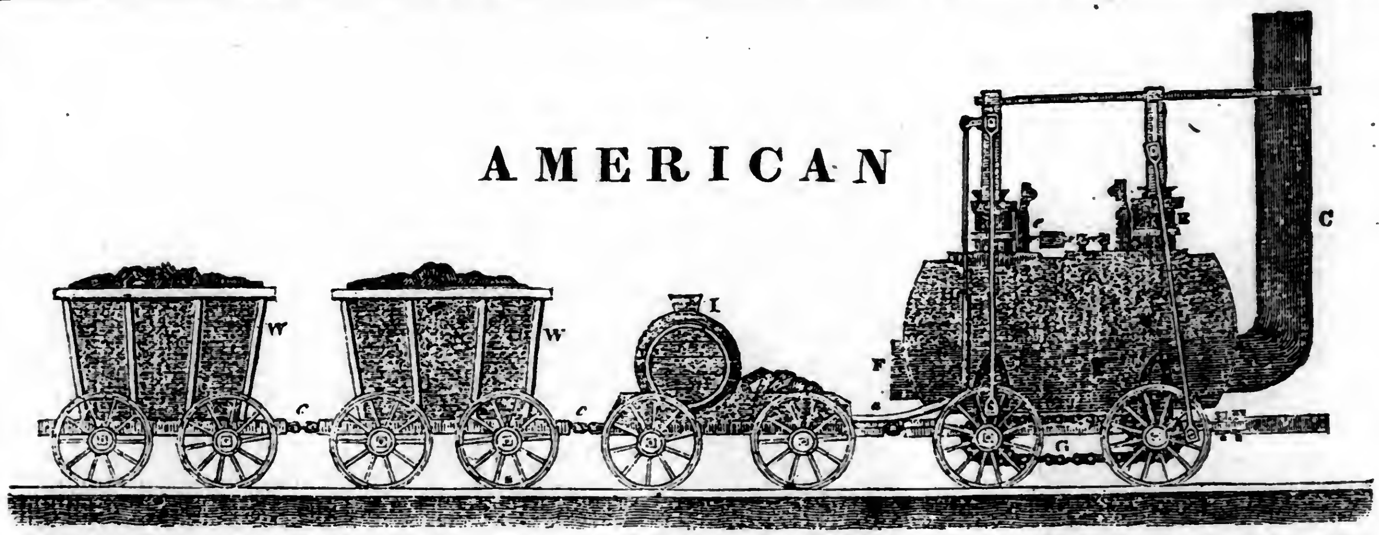
In Nov., 1846, a notice was published that the JOURNAL would thereafter be published in Philadelphia. In January, 1849, the office of publication was removed back to New York, and Mr. MINOR then disposed of his interest



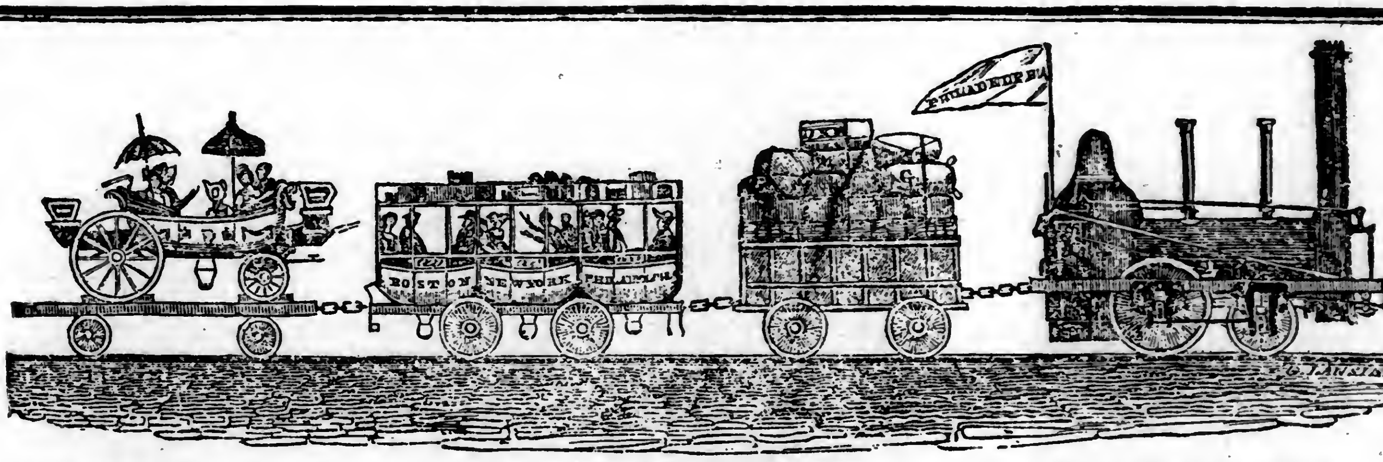
RAIL-ROAD JOURNAL.

VOL. I. NEW-YORK, JANUARY 2, 1832. NO. 1.

AMERICAN



RAIL-ROAD JOURNAL.



AMERICAN RAILROAD JOURNAL, AND ADVOCATE OF INTERNAL IMPROVEMENTS.

PUBLISHED WEEKLY, AT No. 35 WALL STREET, NEW-YORK, AT THREE DOLLARS PER ANNUM, PAYABLE IN ADVANCE.

in it to Mr. HENRY V. POOR, who was its editor until 1862. In 1849 the name of JOHN H. SCHULTZ & Co. appears on the title page as publisher, and later as proprietor. Mr. SCHULTZ retained an interest in the paper until 1882. He then disposed of it, and a company was organized to publish the paper, with Mr. GEO. F. SWAIN as President. Since then it has passed through many vicissitudes and has been conducted by a number of different editors. Its present owner bought it on October 1st, 1886, and with this number it has been consolidated with *Van Nostrand's Engineering Magazine.*

The latter was established in 1869, with Mr. H. L. HOLLEY as editor. He conducted it for one year only, and it was then, and up to the time of its discontinuance, edited by Prof. GEO. W. PLYMPTON. The *Magazine* was largely made up from selections from foreign and other engineering literature, but many original articles by able contributors were published in its pages. To some extent THE RAILROAD AND ENGINEERING JOURNAL publication will be like the *Magazine,* but it is intended, with each number, to increase the amount of original matter, and it will be the hope and the aim of its editor to maintain the high character which the publisher and the editor of the Magazine established during the sixteen years that it was conducted by them.

NEW PUBLICATIONS.

"RECENT LOCOMOTIVES"—*Illustrations, with descriptions and specifications and details of recent American and European Locomotives, reprinted from the "Railroad Gazette."* (Enlarged edition.) New York: published by the *Railroad Gazette.*

The above title indicates the character of this book. It consists of a series of illustrations and descriptions of locomotives which have for some years past been published in the *Railroad Gazette.* It is not in any sense a treatise, and yet as a book of reference it will be found to be of great value. From the way in which it was created it has necessarily a fragmentary character, and as no systematic arrangement was intended, when the illustrations were prepared and published in the *Railroad Gazette,* it has been impossible to systematize them in the book, although the engravings have been arranged in classes for convenience of reference. While a book produced as this one has been is lacking in not having any recognized system of construction, it has another advantage of not being limited by the ideas of its author. It was produced by events, that is, in a measure, it is a record—although not a very complete one—of what has been done in locomotive engineering during the past ten or fifteen years, and for that reason it represents not the ideas of one person but of many.

The printing, paper, most of the engraving, and the mechanical work generally, is very good. The size of the book is 11 x 16 in., and contains over 500 engravings, with a good index. The present edition of the book was compiled by Mr. D. H. Neale.

"LOCOMOTIVES AND LOCOMOTIVE BUILDING"—*Being a brief sketch of the growth of the Railroad System and of the various improvements in Locomotive Building in America, together with a history of the origin and growth of the Rogers Locomotive and Machine Works of Paterson, N. J.* New York: Wm. S. Gottsberger, printer, 1886.

This title is explanatory of the scope of this volume, which has just been issued by The Rogers Locomotive and Machine Works. As this book was prepared by Mr. M. N. Forney, criticism of it in these columns would hardly be in order. The following preface will give an idea of the contents and aims of the book:

"The last catalogue of the Rogers Locomotive and Machine Works, with a sketch of the origin and growth or that establishment, was published in 1876.

"Since then many changes have been made in the equipment of these works, and in the character, design and dimensions of the locomotives turned out. To describe these adequately, it was necessary to rewrite nearly the whole of the former volume. This work was entrusted to my hands by the officers of the Rogers Locomotive and Machine Works. As it was commenced during the fiftieth year that the establishment had been engaged in the manufacture of locomotives, it seemed a suitable time to give a somewhat full account of the origin and history of the works, and of the evolution of the locomotives built in them during that period. Such an account has been carefully prepared, and consists very largely of what may be called a mechanical history of the work which has been done; which, it is thought, will be interesting to many readers, as it shows the successive steps which have led to the wonderful development of the locomotive in this country. It also indicates the extent to which the perfection of the modern American type of locomotive is due to the ingenuity, mechanical skill, and sound judgment of the founder of this establishment—Mr. Thomas Rogers, and to his successor, Mr. William S. Hudson. Both of them have left a record of their genius and ability in their designs, which are imitated to-day, and which promise to survive until locomotives are superseded.

"Very complete data concerning the dimensions and performance of the locomotives, which this establishment is now prepared to furnish, are given by illustrations and tables in the latter part of the book, and as there is still considerable difference of opinion and practice in calculating the capacity of locomotives, an explanatory chapter is given showing just how the calculations were made."

M. N. FORNEY.

The first portion of the historical part is republished in another part of the JOURNAL, and the remainder will appear in future numbers. The following are the headings of the chapters. The author claims credit for the index only:

"The Origin of the Rogers Locomotive and Machine Works;" "The Early History of Railroads in this Country;" "The Early History of Locomotives in this Country;" "History of Locomotive Building at the Rogers Locomotive and Machine Works;" "The Organic Development of the Locomotive: The Boiler: The Engines: The Running Gear;" "The Rogers Locomotive and Machine Works in 1886;" "A Remarkable Run of 426.6 Miles by Rogers Locomotives on the New York, West Shore & Buffalo Railway;" "The Tractive Power of Locomotives;" "Plates and Tables of Dimensions and Capacity of Locomotives of 4 ft. 8½ in. Gauge, or Wider;" "Plates and Tables of Dimensions and Capacity of Narrow Gauge Locomotives;" "Index."

"THE LIFE OF ROBERT FULTON, AND A HISTORY OF STEAM NAVIGATION"—*By Thomas W. Knox.* New York and London: G. P. Putnam's Sons, 1886.

The author of this book says in his preface that he pre-

pared it "in the belief that a history of steam navigation, combined with a biography of the man who designed and built the first successful steamboat, would be of general interest. The use of technical terms, whenever possible, has been avoided, in order that the work might prove acceptable to youthful or non-scientific readers, as well as to those with whom steam navigation is a special study."

As a consequence, the book has more of a popular than a technical character, and is very interesting. The author has apparently investigated very carefully the sources of his information, and the life is largely based on original documents, many of which are reprinted. The book contains many illustrations of Fulton's and other early steamboats, and of later examples of boats and ships. Of the illustrations, he says that, "those referring especially to Robert Fulton are mainly reproduced from Mr. Reigart's biography; they were made originally from drawings by Fulton, and now in the possession of his descendants." To any one who has had experience of the way in which drawings degenerate, the author's easy reliance on the authenticity of those given by another writer is not very assuring of their correctness. It of course takes a great deal of time to investigate and test the accuracy of material of this kind, but a biographer should be willing to do this if he undertakes to write a history of the life and work of a man as distinguished as Fulton was.

The history of steam navigation, which the book contains, while it is interesting, is very fragmentary and superficial, and is evidently not the work of an expert. The material is such as might easily be collected by a not very extended course of reading, and although it is put together in a very readable form, it is not what such a history ought to be, Generally, it may be said of the book that it is good popular reading, but rather indifferent history.

Fulton was buried in Trinity churchyard in New York. The author calls attention to the fact that "the grave of the builder of the first successful passenger steamboat, and of the first steam ship of war that was ever launched, is unmarked by a monument, or even by a stone of any kind bearing his name." Surely this neglect ought to receive the consideration of the engineers of the country.

BOOKS RECEIVED.

"A PRACTICAL TREATISE ON THE GASES MET WITH IN COAL MINES"—*By the late J. J. Atkinson, Government Inspector of Mines for the County of Durham, England.* Van Nostrand's Science Series.

"THE THEORY AND PRACTICE OF SURVEYING"—*By J. P. Johnson, C. E.* New York: John Wiley & Sons.

C. Shaler Smith.

The news of the death of this well-known engineer has been received as the JOURNAL is going to press, so that there is time for only a brief mention.

Mr. Smith was born in Maryland, and selected the occupation of a civil engineer when his education was completed. He was for some time associated with the Latrobes—father and son—in Baltimore, and afterward became the engineer of the bridge over the Missouri River at St. Charles, and assisted Captain Eads on the St. Louis bridge. Recently he was engaged in building the bridge over the St. Lawrence, near Montreal. His death occurred in St. Louis on December 19th.

OBITUARY.

Leander Garey.

THERE is no one connected with the department of railroad engineering, with which Mr. Garey was so long identified, whose loss would cause such sincere and general sorrow, as did the announcement of his death, which occurred at his home in Hartsdale, Westchester County, New York, on November 24. He died of typhoid fever which probably resulted from fatigue and exposure in conducting an Agricultural Fair, which was held near his residence, just before his illness.

Mr. Garey was born in York County, Maine, Aug. 27, 1827, and he was therefore in his sixtieth year, at the time of his death. His father was a carpenter and joiner by trade, and a farmer as well; part of his time being occupied in working at his trade, and part in farming. When Mr. Garey was about ten years old his father bought a farm in Dover, Maine, and the family then moved to that place. That part of Maine was then a comparatively new country. Only ten acres of the hundred which comprised the farm were cleared. While Mr. Garey lived there with his father, he learned the carpenter's trade, and assisted, as New England boys generally do, in all the work there was to be done. He and his brothers, went to the district school, which was open only about four months in the year, and as one of his brothers expressed it, "we picked up such an education as we could." He remained with his father until he was nineteen years of age and then went back to York County, where he was born, and lived with an uncle so that he could have the advantages of the schools there which were better than those in Dover. Afterward he returned to his home and finished his trade. In 1850 he took a voyage—after the manner of many another adventurous boy—and finally landed at New Orleans, where he fell ill with a fever, and was sent to a hospital. Before his entire recovery he eluded the doctors and left the hospital and returned north. On his way home, and while waiting in the New Haven Depot, he accidentally overheard Mr. French, of Seymour, Conn., say that he needed car-builders in his shop in that place. Mr. Garey volunteered his services, which were accepted, and, although still too weak to work, when he arrived in Seymour, after recruiting his strength, he commenced work for Mr. French. The accidental circumstances in the New Haven Depot, shaped his whole subsequent career. He worked in Seymour for two or three years and then entered the service of the Naugatuck Railroad, in Bridgeport, Conn. While in Seymour he met Miss Hawkins, who became his wife in 1852. He continued in the service of the railroad in Bridgeport until 1855, when he was appointed Master Car Builder of the New York & Harlem Railroad, at a salary of $600 per year. The shops were then in New York City, where the Grand Central Depot now stands. Later the shops at Morrisania, which were burned a year or two ago were built, and he had charge of them until 1873, when he was appointed Superintendent of the Car Department of the New York Central & Hudson River Railroad. The following letter will indicate better than anything else can the opinion which the late Wm. H. Vanderbilt held of Mr. Garey's character and ability.

"The New York Central & Hudson River Railroad Co.,
Office of the President, Grand Central Depot,
New York, Oct. 20, 1873.

"Mr. Leander Garey:

"DEAR SIR:—You are appointed Superintendent of the Car Shops of

LEANDER GAREY.

WILLIAM WOODCOCK.

the New York Central & Hudson River Railroad Co. and its divisions, the appointment to take effect from this date.

"It is not necessary that I should express to you in detail, in this communication, the duties devolving upon you by this appointment; it is sufficient for the purpose, that I state that my confidence in your ability, integrity and efficiency, has induced me to place in your charge the general supervision, control and direction of all new construction, general repairs and expenses, including the estimates and requisitions for purchase of all materials relating to construction and repairs, at the car shops of this company.

"Your designation to this position, is a step long contemplated towards the organization of the car shops into a department, with one person at the head of it, having general powers, and from whose experience and intelligence I can hope to receive all needed information for my consideration and action.

"The immediate result of your appointment, it is expected will be the introduction of order and economy in the shops, and the institution of a system of direct reference to you for authority for any and every expense to be incurred.

"For the accomplishment of the beneficial results anticipated by me, ample power is given to you.

"The position is one of trial and trust, requiring experience, fidelity, discretion and energy to insure success. In the discharge of its duties you will always have my official and personal encouragement. Your relation to the heads of other departments will be advisory, and it will be your duty, as I believe it will be your pleasure, to co-operate with them as far as possible, in protecting and promoting the interests of the company.

"I remain, dear sir, very truly yours,

"W. H. Vanderbilt, Vice-President."

His relations with Mr. Wm. H. Vanderbilt, and his father before him, were of the most confidential and friendly character, and there can be little doubt that they were both very much influenced by Mr. Garey's advice and opinions in those matters which he understood best. He occupied the position on the New York Central road until January 1st, 1885, when he resigned, and soon after he took a pleasure journey to California, which seemed, on his return, to have rejuvenated him, and to have given him a fresh lease of life.

His illness was without premonitions, and from the beginning the fatal disease assumed a very maligant type.

Mr. Garey was, however, more widely known through his connection with the Master Car Builders' Association, of which he was one of the organizers, and in its work and meetings he took an active part. In 1870 he was elected Secretary, and in 1874 he was made President, and was re-elected to that office for ten consecutive years. The writer of this account of his life, has had exceptional opportunities of knowing the deep interest, the zeal and the great amount of work which he devoted to the interests of that Association, and he can say, that to Mr. Garey, more than to any other person, the success of that Association is due. In its critical periods, he was ready with his advice and tact, to steer it clear of the rocks in its way. He was always on the side of progress, and hardly a step in advance was taken in which he was not a leader. In 1872 a resolution was adopted, "that a committee be appointed with power to publish an illustrated book, defining the proper terms or names of each and every part used in the construction of railway cars and a description of the use of the same." Mr. Garey was one of the Committee, but probably neither he nor any other member of it realized the work which they had undertaken. The Committee at first consisted of ten members, who held several meetings. The meetings were very amusing, as agreement among the members was impossible, and it soon became obvious that a committee of ten was too unwieldy to construct a dictionary. The Committee was finally reduced to three, of which Mr. Garey and the writer were members. The work to be done was rather remarkable. The art of car building had grown and been differentiated—as Herbert Spencer would say—more rapidly than the language relating to it. The need of the car-builders, which led to the appointment of the committee, was, that there were no common names for the different parts of cars, so that if a car-builder in Chicago wanted to order castings from another in Boston, it was not at all certain that the Boston man would know what his Chicago friend meant by his terms. In other words, there were no common words to designate the different parts of cars, and in some instances, a term was applied to one thing in one place, and to quite a different one in another. The task of the committee was to establish, and often create, terms to designate all the parts of cars. This, as has already been stated, was a task very much greater than any of the Committee ever imagined when they were appointed. Mr. Garey took up the work with enthusiasm. The plan which was finally adopted after a good many ineffectual efforts were made, was to assign the work to be done to one person, the other two members acting as advisers. No record was kept of the meetings, but probably as many as fifty were held before the book was completed. These meetings were generally of several hours' duration, and Mr. Garey was seldom absent from any of them, and he always took a deep interest in what was done. Whatever value the Car Builders' Dictionary may have, is largely due to the knowledge and assistance which he contributed to the work, and to his indefatigable efforts in completing it.

He has left a wife, three daughters and one son, who, with his many friends, will mourn his death. He was always honored by the affection and esteem of his employés. By all of them, by the members of the Association of which he was President, and all who were ever brought into near relations with him, his death has been the cause of profound sorrow.

William Woodcock.

It is a singular coincidence that the notice of the death of Mr. Garey, who, for so many years, was the President of the Master Car Builders' Association, and that of William Woodcock, the President of the Master Mechanics' Association, should appear simultaneously in so many papers. William Woodcock died at his home in Elizabeth, N. J., at noon on Nov. 27. He had been ill about three weeks.

He was a native of England, and came to this country when a child. He learned the machinists' trade in a railroad shop at Parksburg, Chester County, Pa., and soon after became foreman of a shop in Harrisburgh. Afterwards he was made foreman of the repair shops of the Delaware, Lackawanna & Western Railroad in Scranton. From there he went to Philadelphia, as Superintendent of the Philadelphia & Reading Railroad shops, at Ninth and Green streets. In 1870 he was offered the position of Master Mechanic of the Central Railroad of New Jersey, which position he held under Mr. Peeples, who was Superintendent of Machinery. On the resignation of the latter gentleman his duties were delegated to Mr. Woodcock, and he occupied this position until his death. He had charge of the machinery of the Central Railroad of New Jersey, the Long Branch and New Jersey Southern Branches.

Mr. Woodcock was one of the class of mechanics, which is so large in this country, who have come up from the ranks and been promoted to more responsible positions. He took a very great interest in everything relating to his

occupation, and especially in the affairs of the association of which he was President. Although not a highly educated man he was a diligent student of all that related to his calling, and took a keen interest in all improvements in the machinery of railroads. He was chosen Second Vice-President of the Master Mechanics' Association in 1884, First Vice-President in 1885, and last June was elected President. In one of the local papers of Elizabeth it was said that:

"Mr. Woodcock was a man of quiet, unassuming manners, and yet public spirited, taking an active interest in the welfare of the city. He was a man of great benevolence, doing much for charity that escaped publicity, and was never heard of except through the beneficiaries. He was also connected with benevolent institutions. He was one of the Board of Directors of the Elizabeth General Hospital and Dispensary; and a Trustee of Evergreen Cemetery.

"In politics he was a Democrat, and as the candidate of that party was elected a member of the Board of Education from the First ward, when that ward had a pronounced Republican majority. Mr. Woodcock served well his constituency, and brought an experience in educational and mechanical affairs into the management of the schools that will be of a permanent benefit. He was, at the time of his death, and had been for several years, a member of the Board of Health, where, too, his mechanical skill was of great practical use in matters of this department.

"Mr. Woodcock was an active church worker, and in none of his public relations will his loss be more severely felt than in the Marshall street Presbyterian Church, of which he was one of the elders.

"He was a member of the Knights Templar Commandery in Lancaster, Pa.

"Mr. Woodcock leaves no immediate family. His wife died a few years ago. A sister and brother survive him. His death falls with much severity upon a niece, who had a home at Mr. Woodcock's since a child, and was as a daughter to him.

"The railroad company recognize the loss of a valuable and faithful employé, whose place cannot be easily filled. The hundreds of men who for years have been under his direction will regard his death with feelings of great sorrow. He was a kind and helpful master, and esteemed by all who had dealings with him. Mr. Woodcock was 52 years of age."

Walton W. Evans.

THE death of this distinguished engineer occurred in his seventieth year, in New York, on Nov. 28th. The following account of his life is from the *New York Herald:*

"At the time of his death Mr. Evans was, with a single exception, the oldest living graduate of the celebrated Polytechnic Institute at Troy, in this State. One of his first connections with that series of railroad works of magnitude which have made his name famous, not only on the American continent, but in Australia and New Zealand, was his association with the engineers who built the Harlem Railroad.

"He continued in the practical exercise of his profession for several years in different sections of the country wherever engineering skill was required to push the lines of communication from city to city and State to State, in defiance of every obstacle in the way. He was then invited by the Chilean government to visit that country, where he at once commenced building railroads, being, soon after his arrival there, appointed Chief Engineer under the Republic. In this capacity he built nearly all the important railroads which traverse that country. He visited several of the other South American republics, projecting and building railroads, and adding to the prosperity of the government and the happiness of the people by his works.

"Besides his railway enterprises, one of which was the building of the first steam railroad south of the Equator—an enterprise of which he was especially proud—Mr. Evans designed and superintended the erection of many of the public edifices and private mansions which adorn the capitals of the South American republics. Central America and Mexico are also indebted to the deceased engineer for the blessings of that higher civilization which follows on the opening of railways through rich and fertile countries previously undeveloped.

"He also devoted his time to the consideration of canal construction, and has written a series of articles on inter-ocean canal communication which have attracted great attention on this continent and in Europe. He was an indefatigable student, never wearying in the study of the problems which presented themselves in the carrying out of novel and previously untried enterprises, and elucidating, with the accuracy of the draftsman and the clearness of an apt writer, the difficulties presented and overcome in his experiments. Many of his writings in this direction are valuable additions to the engineer's library.

"Mr. Evans was a member of the Institution of Civil Engineers, the American Society of Civil Engineers, and of the Council of the American Geographical Society. He has also filled many positions of trust and responsibility on special occasions in connection with his profession, bringing his close study and critical test of every new invention and design into practical operation. Whenever in the employment of foreign governments or corporations, he contended for and always secured the introduction of American mechanical products in the prosecution of his undertaking. His loss will be deeply felt by his professional brethren, not only in his own country, but in those lands where, through his works or writings, his name is known.

"Mr. Evans was the grandson, on the maternal side, of General Anthony White of revolutionary fame, and was a member of the Society of the Cincinnati."

Mr. Evans was an enthusiastic advocate of American ideas and methods in engineering matters, and to him the introduction and use of American rolling-stock and machinery in South America, Australia and other foreign countries was largely due. He was one of the few engineers who discovered the fallacies of the narrow gauge illusions, which, about fifteen years ago, were disseminated in this and other countries. He was a frequent writer on engineering subjects, and when he did write, it was always to express some very pronounced and decided views on the subjects he discussed.

He was appointed the agent of a number of South American and other foreign enterprises, in this city, some years ago. He was entrusted with the responsibility of purchasing the rolling-stock and supplies, engaging the engineering staff and transacting the business generally of these enterprises—all of which was left largely to his discretion. Owing to the infirmity of defective hearing, he went little into society, and his diversion consisted

largely in the study of engineering matters, for the discussion of which he was always ready, and which he would take up with all the enthusiasm of youth.

His death has removed one of the type of engineers—who are now disappearing so rapidly—who were trained during the period of the growth, or rather the creation of engineering in this country. Besides the knowledge and ability as engineers which distinguished these men, many of them have been noted for their kindly human sympathy, benevolence and magnanimity, which are sadly missed as they one by one pass away.

Martin Coryell.

OUR personal record this month mentions the deaths of an unusual number of prominent engineers. One of the latest on the list is Mr. Martin Coryell, the well-known mining engineer, who died at his home in Lambertville, N. J., Nov. 29th, aged 71 years. He was born in New Hope, Pa., in 1815, and received his education in the schools of that place and in the academy at Lambertville, then a school of some local reputation. Mr. Coryell early began his training as an engineer, and continued work in that profession until his death, with the exception of two short intervals in his youth, one when he read law for a short time in Philadelphia, in the office of Mr. Benjamin H. Brewster (afterward Attorney General of the United States), and one when, after a severe illness, he worked at the carpenter's bench to restore his health. His first work as assistant engineer was on the Delaware Division Canal in Pennsylvania, and he subsequently served on the Delaware & Raritan Canal in New Jersey. Here he was associated with the late Ashbel Welch, who was, years afterward, his friend and neighbor; and he subsequently assisted Mr. Welch in the location and construction of the Belvidere Delaware Railroad. This was his last railroad work, for he then turned his attention to mining engineering. He was one of the pioneers in mining in the Lake Superior copper region, and, on his return from the West, was connected with the development of the Hazleton anthracite field, and of the other coal fields opened by the building of the Lehigh Valley Railroad. In 1862, his coal mining work led him to settle at Wilkesbarre, Pa., which was his home for several years. In 1864, he was appointed manager of the Warrior Run Coal Co., and directed the operations of that company for several years. About 1875, he left Wilkesbarre and settled in Lambertville, N. J., his time being fully occupied by his coal interests and an extensive practice as consulting engineer, his advice being sought as that of a leading expert in his profession.

Mr. Coryell was one of the founders of the American Institute of Mining Engineers, and was always an active member, taking part in the meetings and contributing valuable papers to the proceedings. His death is regretted by a wide circle of friends.

Submarine Warfare.

(From the *London Times.*)

THE question of submarine warfare would appear to be advanced an important stage by a new submarine torpedo boat, which was tried on Saturday, November 27th, in the West India Docks. The great problem for solution in this class of boat is a simple and ready means of effecting submersion quickly, and of again rising to the surface as frequently as may be desired. Many attempts have been made to compass this object by means of screws, inclined planes, water compartments alternately filled and emptied, and other contrivances. The present invention, however, involves none of these principles. The principle upon which the immersion and emersion of the new boat depends is simply that of displacement. While lying on the surface, the boat has a given amount of displacement. To effect immersion, this displacement is reduced, and when it is desired to raise her to the surface again the displacement is increased. A fair analogy is that of a telescope dropped into the water when extended for use, in which condition it will float for a given time. If dropped into the water closed up it will straightway sink to the bottom. The idea of utilizing this principle originated with Mr. Andrew Campbell, and was worked out in practice by him in conjunction with Mr. Edward Wolesley and Mr. C. E. Lyon, and the vessel in which the joint ideas of these gentlemen have been embodied has been built by Messrs. Fletcher, Son & Fearnall, of Limehouse. This boat is cigar-shaped, and pointed at both ends, being 60 feet long and 8 feet in diameter amidships, exclusive of a slightly raised central deck. Her displacement, when fully immersed, is about 50 tons. She is built of ⅜-inch Siemens-Martin steel, and is driven by twin screws, the motive-power being electricity, which is supplied from a storage battery to motors of 45-horse power. Electricity also supplies light, when submerged, by means of glow lamps. Air under pressure is stored on board, and there is accommodation for a three days' supply; the electric batteries also have a similar storage capacity. The electrical machinery has been designed by Mr. Graydon Poore, and supplied by Messrs. Lewis Olrick & Co.

When lying on the surface of the water, a depth of only about ten inches of the central upper portion of the boat is visible above water-line, and this is surmounted by a steel conning tower about 12 inches high and 15 inches diameter, and pierced with four sight holes. Entrance and exit are obtained by means of a manhole on the deck which is secured with a watertight joint, and there is room for six persons in the central portion of the boat. Displacement is increased or reduced by means of cylindrical chambers, which are projected or withdrawn telescopically from the sides of the vessel, and by this simple means she can be made to rise or fall in the water, slowly or quickly, at the will of those in command. This was amply demonstrated on Saturday, when Lord Charles Beresford, with others, went down in her, Lord Charles expressing himself very strongly as to the value of this new vertical manœuvring power. The boat was many times submerged to the bottom of the dock, about 17 feet, and brought to the surface again on a perfectly even keel. She was also propelled a short distance, connection being made with the batteries by hand, but as the motors were not coupled up with the current nothing further was attempted. The area for a run, moreover, was too circumscribed, there being a number of vessels lying in the docks, which would have impeded progress. The main application of the system would appear to lie in the direction of submarine warfare, although it is not intended that it shall subserve this purpose exclusively, as the inventors have designed arrangements for applying it to all classes of submarine operations in lieu of the diving bell. It is also to be observed that, although only applied to a 60 feet boat, this size in no way indicates a limitation of the principle, which can be applied to any sized vessel.

Contributions.

NATURAL GAS.

A MONOGRAPH.

BY CHARLES PAINE.

NATURAL gas, or Rock gas, as it it often called, is a fluid of vapor of about one-half the specific gravity of atmospheric air, varying, according to the place of its origin, from .45 to .55, and of course, according to its composition, which is found to differ considerably in adjacent wells, and even at different times in the same well. There have been many determinations of the composition of Pittsburgh Natural gas, the average of which, adopted by Mr. S. A. Ford, the chemist of the Edgar Thompson Steel Works, is as follows:

Carbonic acid	.6	per cent.
Carbonic oxide	.6	"
Oxygen	.8	"
Olefiant gas	1.	"
Ethylic hydride	5.	"
Marsh gas	67.	"
Hydrogen	22.	"
Nitrogen	3.	"
	100.	

The Findlay, Ohio, gas, as determined by Prof. C. C. Howard, yields:

Marsh gas	92.61	per cent.
Olefiant gas	.30	"
Hydrogen	2.18	"
Nitrogen	3.61	"
Oxygen	.34	"
Carbonic acid	.50	"
Carbonic oxide	.26	"
Sulphuretted hydrogen	.20	"
	100.00	

The heat units in 100 litres of Pittsburgh gas are calculated at 789,694; in Findlay gas at 878,082; and (for the sake of comparison) in the same quantity of Siemen's producer gas at 113,000; these results being the average of several determinations. Experiments under various boilers have shown 1,000 feet of gas to be equal in heating power to from 80 to 133 pounds of coal. The committee of engineers of the Society of Western Pennsylvania, appointed to investigate the question, concluded that one pound of coal was equal in value to seven and a half feet of average Natural gas. It explodes violently when mixed with from nine to fourteen parts of air. The flame temperature of Natural gas, when burned with pure oxygen, is estimated by Mr. F. W. Taylor at 7,100 degrees C., and of the Siemen's producer gas at 2,850 degrees centigrade; when burned with just enough air to insure perfect combination, the temperatures are estimated at 2,333 degrees C. for Natural gas, and 1,700 degrees C. for Siemen's.

The Natural gas has generally but little odor; yet is often found strongly scented with the fumes of petroleum or of sulphuretted hydrogen. The absence of odor has usually been considered a defect, as lessening the chances of discovering leaks from the pipes in which it is carried; but the sense of suffocation produced by inhaling air which has been charged with only a very small portion of the gas, would seem to be a warning of its presence quite as palpable as its odor. The gas is described as colorless, yet it may be seen to have a pale blue tint when blown into the air from a well under high pressure, quite like the column of high-pressure dry steam from a boiler. This color may be due to the presence of minute quantities of water, or of oil, in suspension; for, as discharged from the wells, there is always some moisture and some oil, which may be separated from the gas by discharging it into a tank on its way to the conducting mains, the precipitated water and oil being drawn off at proper intervals.

The theories of the origin of gas are several; and it is not worth while to discuss them here at much length, because none of them accounts for all the facts; and, at present, the theories have not much practical bearing. The probabilities are that petroleum and gas are derived from the same sources; they are always found in conjunction. They appear to have been produced from organic matter, to have escaped from the region in which they were produced, and to have been entrapped in certain open or porous rocks, where they have remained imprisoned until discovered by the drill, or by their issuing through crevices in the rocks, leading to the surface.

It is probable that gas may be found in any of the strata which have been deposited since the Archæan rocks. In Northwestern Ohio the gas is found in the Trenton limestone, which is in the second series of strata above the Archæan rocks; and more or less gas has been found in each of the subsequent strata up to the coal measures; indeed, it exists even in the glacial drift.

Starting at the oil region in Upper Canada, passing through Black Rock to the southwest corner of Pennsylvania, the sedimentary rocks dip gently and somewhat uniformly to the southwest, the lower rocks outcropping at the northeastern end of the section, while the full series, extending to the upper barren coal measures, are found at the sonthwestern end. It is remarkable that upon this line, the oil or gas, in profitable quantity, is found only in those strata of sandstone which happen to be at a depth of from 500 to 2,000 feet below the surface; and that deeper drilling in any place along this line has not succeeded in finding a stratum which was, at that place, productive of either oil or gas in valuable quantity, although yielding both in abundance at some other locality, where it is nearer the surface.

In Canada, the oil is found in the Carboniferous limestone. As we go southwestward, the Bradford sand, the next group above, is the productive stratum; still further south, the Warren oil group, which lies above the Bradford; further southward, and above the Warren, the Venango group of sands, and still further to the southwest, the Conglomerate measures yield the gas and oil. In Northeastern Ohio, in the vicinity of Mecca, the oil is found at small depths, less than one hundred feet, in the Berea grit, immediately under the bowlder clay; but its gas, and almost all the volatile products usually contained in the petroleum, have been evaporated; in consequence of which the oil attains the gravity of from 26 to 28 degrees "B," which made it the valuable lubricating substance for which there was a wide demand, so long as its production continued. The gas and oil in Northwestern Ohio, found in the Trenton, lie about 1,100 feet below the surface.

The reservoirs of gas and of oil seem to vary in dimensions from the smallest pocket up to thirty or forty square miles in extent, and one hundred feet or more in thickness. It is important to the finding of the gas that the rocks shall not have been violently disturbed and broken, because the gas certainly would have escaped through the openings produced by the fracture of the rocks; so that it would appear idle to search for it in the immediate

proximity of mountain chains; but it may be looked for in almost any quarter, wherever the strata have not been violently disturbed, between the Upper Carboniferous and the Archæan. In Southwestern Pennsylvania these strata are very closely conformable and of remarkable uniformity in thickness; but in no other part of this country is it possible, without very careful investigation to determine at what depth a specified stratum will be found. The several contiguous strata may contain water, oil and gas in intimate mixture, or they may be separated by short intervals one from the other. The natural expectation that the gas would be found at the top, then the oil, then the water, is frequently reversed; and in some places we first pass through a stratum of salt-water, then a stratum yielding oil, and finally reach the gas in a lower stratum. It is manifest that there is no communication between the strata, where this condition of things exists. When first reached, the tension of the gas is commonly very high. The highest measured pressure of which we have knowledge is 750 pounds to the square inch; but, from various phenomena exhibited, and the judgment of well-diggers, familiar with these astonishing pressures, we may conclude that a thousand pounds per square inch is not very unusual at the first penetration of the drill into the reservoir. It is not at all uncommon for the drill, and the rope, and even the casing, to be blown out of the hole, from a depth of 1,500 feet, over the top of the derrick, like an arrow from a bow-gun. In any given pool, as it is called in the oil country, there seems to be a sufficient porosity of the rock, in which the deposit is contained, to admit of an approximate equalization of pressures among the several wells, so that throughout an area of one or two miles square, the wells, if shut in, will have substantially the same pressure, not varying among themselves more than thirty or forty pounds per square inch.

For the last few years, much credit has been attached to the anticlinal theory, in the searches for oil and gas. The drillers, in Western Pennsylvania, have faith in an angle of 45 degrees from the meridian, northeast and southwest; so that a successful well having been obtained, they immediately start the drills upon a line protracted upon the northeastern and southwestern courses from it. It happens that in Western Pennsylvania the folds in the strata, which form the anticlinals and synclinals, are approximately parallel with the crest of the Allegheny Mountains, which run rudely to the southwest from the northern boundary of the State, although with a very decided bend, which is followed by the foldings, and also by the remarkable parallelism of the oil territory, so far as it has been exploited. Of course, the real position of the anticlinal fold can only be determined by careful geological explorations on the spot. Prof. I. C. White, the champion of the anticlinal theory, has had remarkable success in the location of the wells which have been sunk under his direction; nevertheless, there are excellent gas and oil producers, which lie exactly in a synclinal trough. It, therefore, appears of more consequence to find a reservoir which has received and retained the gas, than that it should be situated either at the top or bottom of a fold in the strata. Of course, upon the exhaustion of the reservoir, the last few pounds or ounces of pressure would be obtained from the summit of the reservoir; but only the drill can tell whether the reservoir extends to the top of the fold, or lies entirely in the bottom of the synclinal. The reservoirs in the sandstones were formed before the folding of the strata. The denser strata of sandstones or shales surrounding the porous masses, containing the gas, do not seem to be permeated by it in any sensible degree. Those who wish for more particulars on this point, are referred to the interesting discussions by Professors Leslie, Ashburner, Carll and White. At the last meeting of Mining Engineers at St. Louis, Mr. Ashburner read an especially instructive paper upon the geologic distribution of Natural gas in the United States; which will be found among the proceedings of that Society. In it, he thoroughly explains how mystified and misled any but an expert geologist must be, in an endeavor to calculate the depth at which certain strata will, at any point not contiguous to previous drillings, be reached; yet such an expert geologist can advise, after sufficient examination, with reasonable certainty as to the depth at which strata, capable of bearing oil or gas, may be found. Of course, only the drill can tell whether either is there in abundant quantities, or not; even a distance of a few rods or a few feet, may separate a very productive well from a non-productive.

The method of drilling for gas is precisely similar to that employed in drilling for oil, which has been redueed to such a trade and organized business, that one may order from one establishment every article necessary for an outfit. Ordering a "carpenter's rig" from the men who make a business of furnishing such, they will ship to the point desired, for the sum of about two hundred dollars, every piece of timber or lumber which is required for the erection of a standard derrick, with all its attachments; another firm supplies the rig irons for about sixty dollars. The rig-builder, for the sum of about one hundred dollars, will put these parts together; set up in complete readiness for the operations of the driller. The driller furnishes the engine, rope, tools; and drills the hole required (if inside of 2,000 feet deep) at a price varying, with the territory, the hardness of the rock, and the distance from the base of supplies, from $1.00 to $2.00 per foot in depth. If water is encountered, it must be cased off by inserting a tube called the *casing*. The standard well-casing is 5⅝ inches interior diameter, which will go easily into the standard eight-inch hole; the hole below this casing is 5½ inches in diameter. A complete description of the processes of well-sinking, showing the tools used, etc., will be found in Prof. Carll's "Report on the Oil Wells of Pennsylvania," Vol. III, of the Pennsylvania Geological Survey.

One of the most remarkable features of well-sinking is the indifference of the drillers to the loss of their tools. It would seem as if they regard it as a pleasant feature of the business to have a "fishing-job" on hand, as they term it; when they have, by their carelessness, allowed their tools to fall in a hole something over one thousand feet deep, because of the rope or the derrick-head, or something else wearing out and breaking. The next most surprising thing is the ingenuity of the contrivances which have been devised to recover from this seemingly hopeless calamity. In the majority of instances they do manage to pick up the tools and to continue the well. The whole apparatus for well-sinking is of the most rude and simple description of anything known to mechanics; yet so admirably adapted to its work that it would be difficult to improve upon it in any respect, except as to its appearance.

It seems to be well determined that the gas in any reservoir is a limited quantity and not an infinite one, as has been supposed. No doubt the laboratory of Nature

is at work producing the gas, perhaps in very large quantities at the present time, as heretofore; but we do not know certainly that the process of gas production is taking place in the vicinity of the reservoirs which we have discovered. A great many of the small reservoirs have been nearly or quite exhausted, although many of them continued to supply the limited demand which was made on them during many years; and it seems probable that as the oil pools have been exhausted of the larger portion of their contents, so we may expect to finally exhaust the largest gas-pool which has yet been reached. Fortunately, the great thickness of the strata, and the frequency of the occurrence of porous masses in them, suitable for the storage of gas, seems to promise a long-continued supply in those regions, such as Western Pennsylvania and Ohio, where the strata have been but little disturbed. Mr. Peter Neff, of Cambia, Knox County, Ohio, asserts that his *Well No. 2* has been systematically examined during the last fourteen years, and there has been no apparent diminution in the supply during that time, and that the well has been *blowing* during twenty years. Instances of this kind are not infrequent, and have given rise to the theory, supported by Mr. Lorin Blodgett and others, that the hydro-carbons are being distilled now, in vast quantities, at the proper depth below the level of the ocean, and are constantly re-supplying these natural reservoirs through the same avenues by which they have heretofore been filled.

It may be remarked, in passing, that we are beginning to approach the economy of nature in the production of fuel gas; and were the supplies, which are supposed to have been derived from the shales and stored for use in the sandrocks above them, to be completely exhausted, we would be able to substitute therefor a gaseous fluid, for a price quite within the purchasing power of manufacturers.

The search for natural gas, and its exploitation, is being conducted with wonderful vigor. In Western Pennsylvania alone there are incorporated fifty-two Natural-gas companies; perhaps others, the names of which have not been noted. The other Western States are following suit, and there seems to be great promise that Kentucky, Ohio, Indiana, Illinois and Missouri, and perhaps Wisconsin, will be supplied from the Natural-gas reservoirs. The Department of the Interior, of the United States Government, reports the total value of the Natural gas produced during the calendar years mentioned, as follows:

1882	$ 215,000.00
1883	475,000.00
1884	1,460,000.00
1885	4,854,200.00

The useful products of Natural gas besides heat and light are, a superior lamp-black, called diamond-black; and, when improperly burned in furnaces, two forms of nearly incombustible carbon; one resembling in appearance Cannel coal, the other more nearly resembling in appearance a very dense coke, from which superior pencils are made for the electric arc-light. The illuminating power of the gas is low, reckoned at eight candles upon the usual scale. There are many systems by which it is enriched with carbon, in order to improve it as an illuminant, chiefly by the use of the lighter products of petroleum; the mixture being converted into a fixed gas by the use of heat and of superheated steam; but the heat evolved in burning it renders the Natural gas unfit for illuminating any but large or open spaces. It is better to use the gas to produce the electric light through a dynamo. The torches of Natural gas make a very good light for yards, rolling mills and streets. The gas has not yet been successfully used in smelting iron-ore; with this exception, it may be used for all purposes for which heat is required, and is superior for those purposes to any other fuel yet known. It is so perfectly subject to control as to quantity consumed, as to distribution in the furnace, or kiln or oven, and is so perfectly free from sulphur or other objectionable admixtures, that it is held by all classes of manufacturers to be beyond comparison the best and most convenient fuel. For the heating of dwellings and for cooking, it is convenient, controllable, cleanly and most comfortable; it soils nothing; there is no dust attends upon it; it may be lighted in an instant, burns equally for as long as wanted, may be increased or diminished in intensity at will, and may be extinguished in an instant; it is always at hand and requires no attention from the consumer to procure a supply after the pipes are laid. It is supplied almost everywhere, where there are organized companies, at a less price than its equivalent in coal.

The engineering problems connected with the search for gas was nearly all solved during the search for oil; and the dangerous physical characteristics of the gas had come to be thoroughly well understood from experience, by explosions and burnings at the oil wells. Some efforts were early made toward the utilization of the gas, as at Fredonia, N. Y., in 1821, and it was piped in small quantities for the lighting of villages, heating of houses, the burning of brick, the manufacture of lamp-black, &c., upon a small scale. For many years before the piping of the high-pressure gas, for the supply of furnaces, rolling mills, &c., was undertaken, it had been known to gas engineers, and to steam engineers also, that the most difficult part of their operations in conveying these fluids from the place of manufacture to the place of use, was to secure the joints of the pipes from leaking. The reports of gas engineers made within the past year or two, indicate that there is still a loss of from fifteen to thirty per cent. of the total production of gas in cities, due to leakage. Mr. Charles E. Emery, in his admirable lecture before the students of Cornell University, gives a similar account of the losses experienced in the transportation of steam.

Mr. George Westinghouse, Jr., had developed the same difficulties in the making of tight joints, in the transportation of air under high pressure. Becoming interested, through the discovery on his land of the most violent gas-well which has ever been struck, in the transportation of that gas for the supply of consumers in the City of Pittsburgh, he gave his attention to the matter of providing the necessary safeguards against the leakage, which he knew to be inevitable and very dangerous, if the gas was to be conveyed at the high pressures, which would alone admit of its cheap transportation over long distances, and of its distribution through such great areas, as were necessary for the supply of that city. He, accordingly, devised and patented several methods of entrapping and carrying away, by escape-pipes, the gas which would leak from the best joints which it is possible to make; perfecting his system by the purchase of the patents of others. This system of escape-pipes employed by the Philadelphia Company, of which Mr. Westinghouse is President, and which is the largest supplier of Natural gas in the world, will be described in this paper, as the most note-

worthy feature in the art of transporting gas, from an engineer's point of view.

First, As to Pipes and Joints; the screwed joint upon the wrought-iron pipe, is the best and tightest joint that has been made; yet even this will leak when filled with so ethereal a fluid as gas; and under the pressure of eight or nine pounds to the square inch (or fifteen pounds to the square inch, which is allowed by the ordinances of the City of Pittsburgh), this leakage must be very considerable, and it is likely to be aggravated or increased by the variations in temperature, the settling of the ground in which pipes are laid, and many other occurrences. The screwed joint, however, is not as yet made satisfactory upon pipes of a larger diameter than eight inches; accordingly, for larger wrought-iron pipes than this, up to sixteen inches, the Philadelphia Company uses a leaded sleeve-joint, known as the Converse-joint, reinforced by wrought-iron rings shrunk upon the outside of the cast-iron sleeve. For larger pipes than sixteen inches in diameter, cast-iron pipes are employed, tested to a pressure of three hundred pounds to the square inch; not because they have to resist such an interior pressure, but because pipes of this strength have been found capable of resisting the wear and tear of life under disturbed streets.

In all streets, or near dwellings, the screwed joints of the pipes are each surrounded by a conical heap of broken stone, which is covered by a sheet of heavy tarred-paper, perforated at the top for the admission of a trumpet-mouthed pipe, to collect any gas which enters the heap of stones, which rises a few inches above the heap of broken stones, and communicates with a horizontal line of escape-pipe carried parallel with and over the main gas pipes. This escape pipe is carried, at frequent intervals (say every two hundred or three hundred feet) to a lamp-post in the sidewalk, through which the gas, which has been collected in the escape pipe, is discharged into the open air at a point where it can do no harm. In some instances, these lamp-posts are lighted, to serve as *torches* for illuminating the streets; or they are surmounted by lamps, in which a regulated flame burns continuously, giving light by night, so long as there is any gas escaping from the mains. This arrangement has been found to afford entire security against the leakage from the small lines, which might otherwise have penetrated into adjacent vaults and cellars, where it would form a dangerous explosive mixture, liable to be ignited and to destroy lives and property; as has been shown by much experience in Pittsburgh and elsewhere, before this open means of escape for the gas which leaks from the joints had been contrived. The piles of broken stones, provided with an escape-pipe, as described, collect much other gas than that which leaks from the pipes or joints, for which they are prepared as a security; almost always taking up quantities of illuminating gas from the ground, especially when the surface is frozen, so that the porosity of the soil of the streets is destroyed. In other joints than those of the screwed pipe, the safety device employed is a casing around the joint to be protected, forming a chamber in which is collected all the gas which may leak from the joint; the leaking gas being led from this chamber up to a line of escape pipes by a small tube, screwed into the casing and communicating with the chamber surrounding the joint; each joint is thus put in communication with an escape-pipe, which is divided into sections from two hundred to three hundred feet in length, and discharged into the air by a pipe connecting it with a lamp-post in the side-walk. From each joint, the vertical pipe continues by a (cross) above the horizontal escape-pipe to within a few inches of the surface of the street, where it is surmounted by a cap, by unscrewing which each joint can be examined as to the amount of its leakage, with the smallest possible disturbance of the road-bed; so that if any lamp-post is found to yield gas in considerable quantity, it is very easy to determine at which joint the leak occurs; and the leak may generally be remedied by filling the casing, around the joint, with a liquid preparation of asphaltum under pressure, which enters the interstices of the lead joint, and solidifies there. The residue may afterward be pumped out of the chamber, leaving it prepared to receive any leaking gas, as before. Inasmuch as the casing itself may leak some gas into the surrounding earth, because of the imperfections in its joining to the main pipe, heaps of broken stone are placed around these casings, covered by tarred-paper, and surmounted by the trumpet-mouthed collecting pipe, which communicates with a second line of escape-pipe, led off, like the other escape-pipes, at frequent intervals, to lamp-posts in the side-walks. It will be seen that for the larger pipes, two lines of escape-pipes are provided in order to insure open passages to the air, for gas that may leak from the joints of the pipes, or from the joints of the casings surrounding the principal joints of the main pipes. The cast-iron pipes are made with a "bowl and spigot-joint," and are provided with a second bowl, outside of the ordinary bowl, which is converted into a casing surrounding the ordinary lead joint of the first bowl, by the insertion of a ring around the pipe in the outer bowl, which leaves a cavity or chamber surrounding the lead joint; the outer portion of the second bowl being filled with a preparation of asphaltum, which is found to be better, cheaper and more convenient than lead for this purpose. The leaking gas is received into the chamber thus formed between the inner and outer joints and conducted away by escape-pipes, after the manner of the other joints described. The leakage from the joint in the outer bowl is always provided for (as are all external joints in this system), by surrounding it with a heap of broken stone covered with tarred-paper, from which an escape-pipe leads to a lamp-post in the side-walk, as before described. These heaps of stone also gather and discharge into the escape-pipes any gas which may issue from an imperfection in the body of the pipe.

The delivery to houses of gas under such high pressure, as is carried in the main pipes, would be very dangerous; and two methods have been employed for lessening the pressure of the gas in the houses—one by the ordinary tank system, in which one tank governs the pressure carried in a large extent of low pressure lines in the streets and in the houses; the other, which has been adopted by the Philadelphia Company, makes use of a separate regulator for each dwelling or consumer; these regulators being so arranged that they will reduce the pressure in the house or service line, which supplies the fires, to not exceeding that of a column of about four inches of water. They are so contrived that, in case an interruption occurs in the supply from the main line, a valve closes, which will not open again, so long as a cock or any other opening exists in the house lines; thus affording a great security against a neglect to close the cocks at the fires in case of an interruption of the supply, and serving as a detector of bad fittings in the house line. The system of supplying consumers through the individual regulator has

many features to recommend it over the method of supplying by tanks; a large number of consumers being always dependent upon the working of a tank, whereas only one consumer depends upon the working of a regulator.

A brief account of the principal features of the Philadelphia Company's system of mains is necessary to complete a view of the most advanced engineering in the transportation of fuel gas. The Company derives its supply from three sources. At Tarentum it has eleven wells; at Murrysville and Lyon's Run, fifty-four. During the year, the wells have been *shut in*, as it is called, by suspending to the casing of each a platform loaded with stone and earth, of a sufficient weight to overcome the pressure in the wells, which amounts to about five hundred pounds per square inch. The gas therefore is no longer allowed to be wasted by blowing off into the air, when not required by consumers; but is retained in the natural reservoir. It was found necessary to provide cast-steel fittings at the tops of the wells; the ordinary cast-iron fittings not being strong enough to resist the interior strain.

There are thirteen lines of pipes belonging to the Philadelphia Co. reaching the City of Pittsburgh, the lengths of these varying from seventeen to twenty-four miles from the wells to the City Hall. These several lines are inter-connected by cross-lines at several points throughout their length, and begin to ramify at the city limits, sending off large arteries to each portion of the City; from which main arteries smaller ones distribute the fluid through all the considerable streets of the Cities of Pittsburgh and Allegheny, and their suburbs. At the wells, the pipe connections are so arranged that the product of any well may be availed of to increase the pressure in any one of the several lines, so that several wells may be shut off from any part of the system and their places supplied by others, securing any required pressure, upon any line, at all times, It is believed that this Company was the first to adopt the telescopic arrangement for its pipes, increasing them in diameter at intervals on the way to the place of comsumption, so as to be able to deliver a volume of gas at a designated pressure. The usual mode of laying gas mains has been to lay a pipe of uniform dimensions, no matter how long the line, submitting to a loss in both volume and pressure, according to the law of decrease in a uniform tube. In designing the Philadelphia Company's system, care was taken to avoid all dead-ends, and to provide frequent connections between all the main arteries of the system, so that the gas could be carried around in many circuits; and when it becomes necessary to shut off any portion of a main, only the smallest number of consumers will be affected thereby; indeed almost any repairs or changes may be made upon these lines without interrupting any consumer; for, if the gas cannot reach him from one direction, it will reach him from the other. The main lines are provided at their intersections with convenient stations, supplied with gauges attached to each of the lines; with governing valves, and with automatic safety valves, so that the pressures cannot accumulate above a certain tension. There are twenty-one of these stations, at which agents are in attendance night and day, and control the pressures in each section of the pipes, according to the directions communicated by telephone from the office of the General Superintendent; the variations in the consumption on the different lines, making changes necessary from hour to hour, or sometimes, as often as every quarter of an hour. Of course, the automatic safety valves provide against any dangerous accumulation of pressure; but it is desirable not to waste the gas, and to maintain a proper flow in the pipes in accordance with the consumption at the moment. It is expected to provide automatic regulators for this purpose; but at present, human agency is employed, as has been said.

It will have been seen from the foregoing, that the same concern for the protection of human life and for safety from accident, which led Mr. Westinghouse to the invention of the air-brake, has characterized his engineering in the construction of the great system of the Philadelphla Company, which has been so imperfectly sketched. To the writer, his early association with the foremost Company for the transportation of this new and dangerous gas seems a fortunate conjunction, for the people among whom he dwells—which may be called providential.

The bibliography of Natural gas is more extensive than is generally supposed, because the papers are scattered through the proceedings of many societies and through the volumes of geological surveys. The most important papers, because the authors are the most familiar with the subject, are those by Professors Leslie, Ashburner, Carll and White, in the geological surveys of Pennsylvania.

Mr. Ashburner has written several other papers on the geologic distribution of Natural gas, and the oil fields, which form a part of the same subject, printed by the American Institute of Mining Engineers. Mr. McMillan, President of the Ohio Institute of Mining Engineers; Mr. Edward Orton, State Geologist of Ohio; Mr. W. P. Shinn; Mr. Jos. D. Weeks, of the *American Manufacturer and Iron World*, of Pittsburgh, Pa.; Mr. Lemuel Bannister, in a valuable pamphlet entitled "Something About Natural Gas;" Mr. Lorin Blodgett, in *Bradstreet's;* Mr. S. A. Ford, of Pittsburgh, and Mr. F. W. Taylor, in proceedings of the American Society of Mechanical Engineers.

Prof. Newberry, of the School of Mines, and Mr. T. Sterry Hunt, of the Canadian Geological Survey, were among the earliest investigators of the origin of oil and gas.

There is much else which might be referred to, but these references will open up the subject to those who wish to pursue the inquiry in a serious manner.

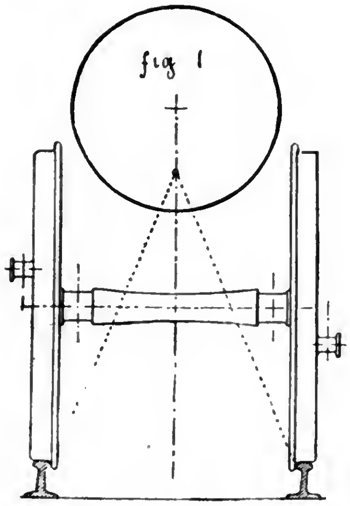
High or Low Center of Gravity in Locomotives.

(From *The Mechanical World.*)

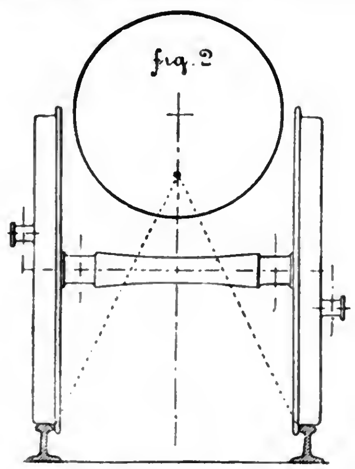
The present writer, venturing to suggest recently that the practice of seeking to design a locomotive so as to obtain a low center of gravity was not only unnecessary but actually harmful, was taken to task for so doing, and now purposes showing that his contention was right, quite apart from its practical demonstration at the hands of those whose duty it is to drive locomotives. Perhaps the chief advantage of a high center of gravity, which is in the main determined by the elevation of the boiler, lies in the diminished effect of lateral blows of the wheel flanges upon the rails. All locomotives in running are more or less liable to these sudden lateral movements which result in very severe blows upon the rails. The difference of action in such cases between an engine with

a high and one with a low center of gravity may be gathered from Figs. 1 and 2.

From a consideration of these two figures, it is easy to see that in the case of the high boiler, any lateral displacement of the wheel flanges at their lowest points—viz., the rail level—is very much less directly transmitted to the center of gravity of the whole machine than is the case with the boiler in Fig. 2. This is due of course to the greater distance of the weight from the rail, assuming, which may fairly be done for comparison, that the whole weight is concentrated at the respective centers of gravity. In the case of the high boiler, the lines of



action—as shown by the dotted lines—pass nearer to a vertical through the springs; and hence these serve to transmit, or rather we should say absorb, shock better than they can possibly do when the center of gravity is lowered. Assuming, for the sake of argument, that the center of gravity could actually be brought to the rail level, a consummation much striven toward not many years ago by some designers, it is by no means difficult to see that the whole mass of the machine in moving laterally would act directly with great severity on the rails, all spring action being absent. Every inch of elevation of the boiler, therefore, brings into action more of the ab-



sorbing action of the springs and reduces the shocks and tremors of a running engine, and the centrifugal action in taking a curve assists in bringing upon the outer rail that excess above the load on the inner rail, which is desirable, and which is sought for in the design of the Bissel bogie or the swing beam; and yet with any reasonable elevation of boiler the action does not approach dangerously near to an overturning point.

A point much overlooked, or perhaps not at all considered in the design of locomotives, is the possibility of the time of oscillation of the engine synchronising with the period of the cause of transverse oscillation. Such a cause was shown in the *Mechanical World* of November 12th, in the inclined position of outside cylinders especially, and the synchronism would be most severe at a certain forward velocity of the engine, less so at half or double this same velocity, and still less at velocities giving no immediate ratio of wheel revolution to period of vibration. To ascertain the probabilities of any special engine, the height of the center of gravity above the center of oscillation would require finding, in order to determine the period of transverse vibration. Such period would best be found by experiment with an actual engine slightly altered in the springs. Knowing this period and the wheel diameter, it could then easily be ascertained what speed in miles per hour would make the wheel revolutions or half revolutions coincide with oscillations of the engine as a pendulum. Should such be the case at the speed for which the engine is desired generally to run, it would be necessary to alter the wheel diameter, to change the rate of impulse, or raise the boilers in any other engines afterward made, so as to alter the "pendulum length."

It would not be difficult so to design an engine, that at any speed the center of gravity could be raised or lowered, if it appeared that synchronism existed at such speed.

The simple turning of a cock by the driver could be made to vary the center of gravity sufficiently to cause steadiness. That such a refinement is necessary may well be doubted, but it is well to know that its attainment is a simple matter, and it is well also to recognize that a variation in the position of the boiler, the diameter of the wheels, or the position of springs and length of spring links, etc., all have a direct and immediate effect on the running qualities of a locomotive in other respects than those generally credited to these details.

Pipe Lines on Sugar Plantations.

Owing to the hot climate of Queensland, it is said to be absolutely impossible to conduct the work of the sugar plantations with white labor and find the industry profitable. To get over this difficulty, a scheme has been tried, to a limited extent, by which the manufacturing processes of making sugar are carried on at a central refinery owned by separate proprietors, or by the different cane growers. According to this scheme, the farmers are to confine themselves personally to cane growing on a moderate scale. In one case, the farmers possess their own rolls, and the juice only is carried into the factory, which is fed from twenty-five separate mills. The juice, after being charged with lime to prevent acidity, is conveyed to the factory either by road or river; but by far the most important manner of transit is by means of an extensive system of 3-inch underground pipes. These have been laid between the various mills and the central refinery, and through them the juice is forced for miles by powerful pumping-engines. The amount of juice treated in this refinery amounted in 1885 to over ten million gallons. The price allowed is £15 a ton; but this, the farmers say, is too low, and that they would get more for their produce were the factory subject to competition. Near the town of Bundaberg, there is a somewhat similar system in operation, a gigantic refinery having been erected at Millaquin.

PERFORMANCE OF A PUMPING ENGINE.

BY JOHN W. HILL, M. E.

THE Gaskill pumping engine recently constructed by the Holly Manufacturing Company, of Lockport, N. Y., for the city of Kalamazoo, Mich., presents so many novel features of construction, and withal has developed such an excellent economy for its dimensions, that a review of the machine and the results obtained upon test trial is considered of sufficient value to justify the following paper.

The engine is vertical, compound condensing, provided with a beam crank and two fly-wheels, with the steam cylinders mounted upon a heavy cast-iron housing over the pumps.

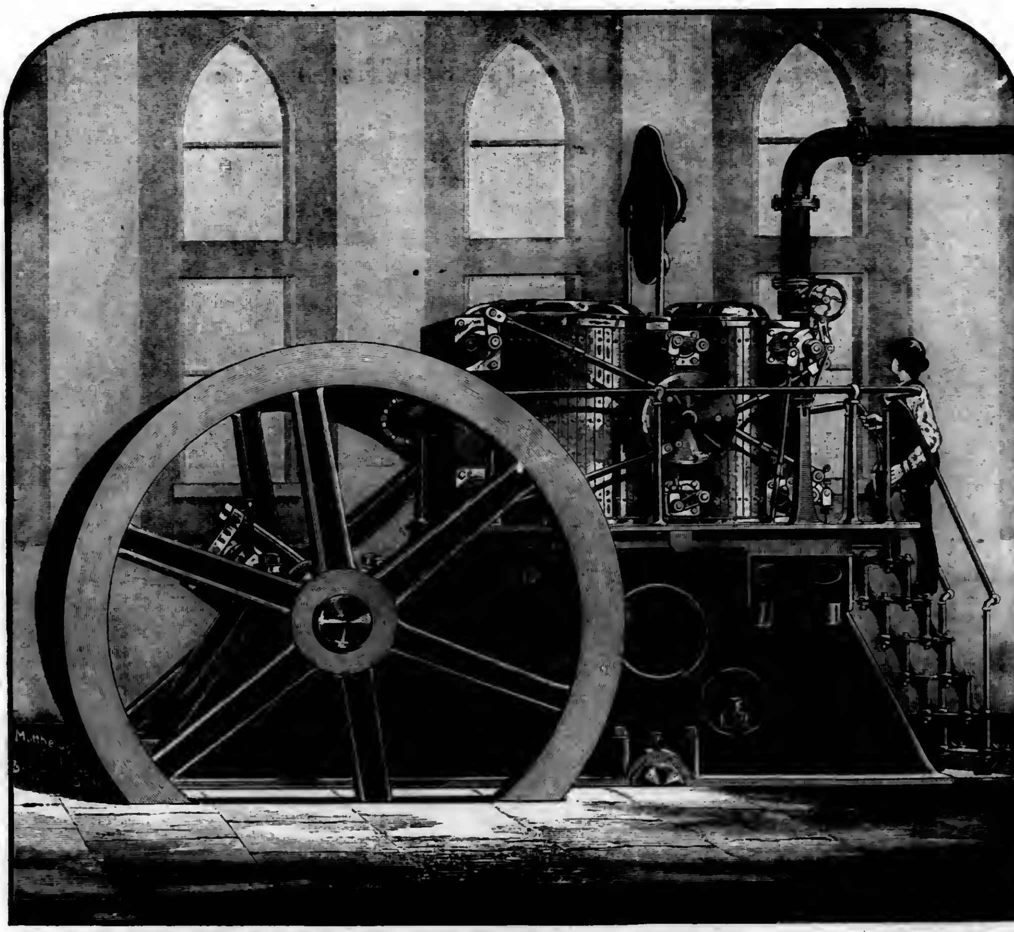


Fig. 1.

The pumps are of the single-acting plunger variety with outside stuffing-boxes, of similar diameters and strokes of plungers; placed in a vertical position three feet five inches from center to center; one plunger being driven by the high-pressure steam piston, and the other by the low-pressure steam piston.

The engine-beam centers turn in bearings in the housing, which are located centrally between the center lines of the high and low-pressure steam cylinders, and about midway between the steam cylinders and pumps. The beam is elliptical in elevation, of two steel-rolled plates, each 1.25 inch thick, 48.5 inches deep at the center, and 46.5 inches from center to center of end pins. The two plates are riveted at the center to a heavy, central cast-iron boss through which the shaft passes, and is provided with cast-iron bosses, riveted on, to form bearings for the working pins. The pin taking the inner end of the main connecting-rod is set 23.25 inches from beam center, and below the pin which takes the lower end of the link of the low-pressure piston.

The crank-shaft is bent at the center to form a pin or journal for the outer end of the main connecting-rod, and overhangs the housing on each side, with a fly-wheel keyed on each end. The bearings for the crank-shaft are set off to one end of the housing and the driving-pin in the working beam set tangential to the crank-pin and shaft bearings, when the crank is on the centers, and the steam pistons and plungers at the ends of stroke.

The bearings and crank journal on the shaft are of similar diameters.

The steam cylinders and heads are steam jacketed, the condensation from the jackets and any surplus steam being trapped back through a closed feed-water heater to the boiler feed pump, from which it is returned to the boiler. (The construction of the jacket drainage and feed-water apparatus is such that a loss by a large flow of steam through the jackets is balanced by a corresponding increase in the temperature of feed-water to boilers, less any losses by conduction and radiation through connecting pipes, which probably would be less than the loss of economy which might occur with an inadequate supply of steam to the jackets.)

The engine housing is bolted to a foundation which rises about 2.5 feet above the floor of the engine room, and the sole plate of the pumps is bolted to the foundation, about 8 feet 4 inches below the floor line.

The entire arrangement of steam and water ends and crank-shaft is as compact as possible, only such spaces

existing as are absolutely necessary to the action or adjustment of the working parts.

The steam valves and gear are of the Corliss pattern, one wrist plate working from five pins the two steam-valves, of the high-pressure cylinder, the two intermediate valves between the steam cylinders and the two exhaust-valves to the low-pressure cylinder. The steam-valves are of the automatic liberating kind, the point of cut-off being adjustable by hand and by the automatic pressure-regulator, which governs the cut-off according to the head against which the pumps are working. The intermediate and exhaust-valves have fixed motions.

Stroke, steam pistons [nominal]	30.0 inches.
High-pressure piston-rod [1] diameter	2.625 "
Low-pressure " " [2] "	3.4275 "
Clearance, high-pressure cylinder, estimated	2.5 per cent.
" low-pressure " "	2.5 " "

Steam cylinders, jacketed sides and heads, with sides lagged, with walnut staves, and upper heads finished with polished covers.

Crank-shaft, diameter, journals	12 inches.
Crank-pin " "	12 "
Fly-wheels, [two] diameter	10 feet.
" " " weight [each]	8,000 pounds.

Air-pumps (two), single acting, bucket pattern, worked

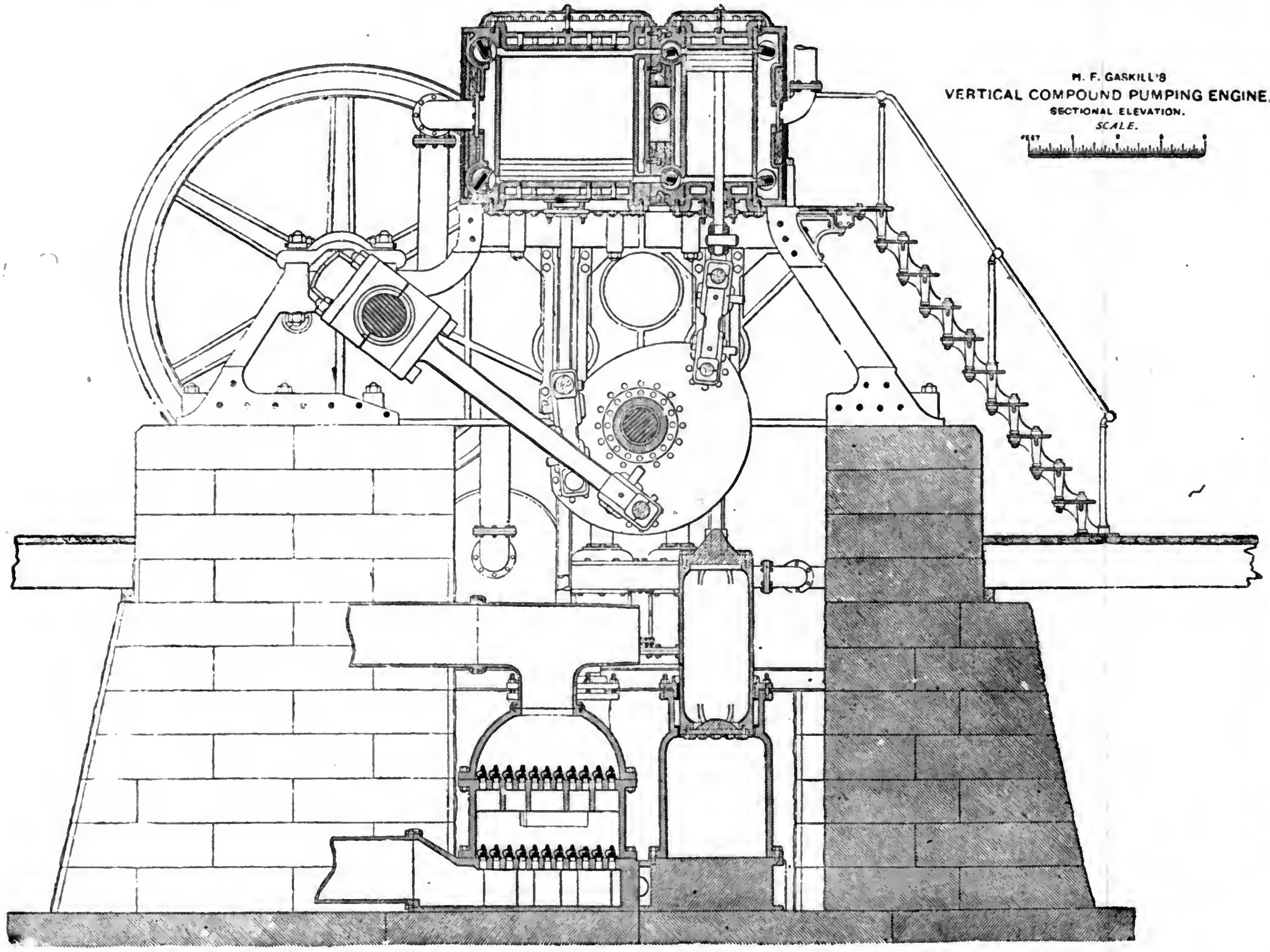


Fig. 2.

The condenser is of the jet variety, taking injection water from the suction pipe of the main pumps.

In the following table are given the principal dimensions of the engine, and arrangement of the principal details. (The pump plungers were carefully measured previous to the trial.)

Plunger driven by high-pressure piston, diameter	20.03125 inches.
" " " " " " stroke	29.96875 "
" " " low-pressure " diameter	20.03125 "
" " " " " " stroke	29.922 "

The other principal dimensions of the engine were taken from contractors' drawings, except steam piston-rods, which were measured.

High-pressure steam cylinder, diameter	18.0 inches,
Low-pressure " " "	36.0 .,

from pins at ends of an even lever, working beam mounted on an extension of the engine-beam shaft.

Air-pumps, diameter	11 inches.
" " stroke	14 "

Boiler feed-pumps are of the single-acting plunger variety, two in number, worked from an even lever beam keyed on the extension of engine-beam shaft, outside the beam, by which the air-pumps are driven.

Feed-pumps, diameter	3 inches.
" " stroke	7.25 "

Pumps are fitted with four sets of small single beat rubber valves, mounted in composition shells, and working on composition seats screwed into the diaphragm of valve chambers.

Each set contains 91 valves, or 364 valves in the suction and discharge chambers of both pumps.

Pump-valves, diameter disc	1.75 inches.
" " " opening in seat	1.3125 "
" " lift	0.3125 "
" " thickness of disc	0.50 "

The valves are guided above the seat by the stem (which moves with the disc) passing through a hub in a three-winged cage, which screws down over a threaded projection of the seat, outside the valve disc.

The lift of pump-valve presents a clear opening between the disc and seat of 1.718 square inches, while the area through the seat is the full area for diameter—or 1.353 square inches. The velocity of flow through the seats, with plungers moving at the rate of 130 feet per minute:

$$\frac{130 \times 315.1425}{123.123 \times 60} = 5.547 \text{ feet per second.}$$

The pumps take water from a curbed well, outside pump house, 20 feet diameter, 25.8 feet deep from coping. The well is supplied by infiltration through the surrounding soil, which passes under the iron shoe upon which the tight curb is built.

The specification and agreement provided that the engine should have a daily capacity of 3,000,000 United States standard gallons of water, at 120 feet piston speed, against a domestic head of 120 feet; should be capable of pumping against a fire pressure of 130 pounds per square inch of pump plungers, with 70 pounds steam pressure by gauge, and should develop a duty of 95,000,000 foot pounds per 100 pounds of best coal (to be selected by the contractor) burned under the boiler, with steam pressure at 70 pounds by gauge.

The contract trial was conducted in accordance with the specification and agreement between the City of Kalmazoo and contractors, and the usages and rules generally accepted in test trials of pumping machinery of the first class.

Previous to the trial, levels were taken of the center of water-pressure gauge from which the pressures were read, of the center of the pumps, and of a bench mark located in the pump well, from which the stages of water in the well during the trial were taken by means of a Chesterman tape and float.

The vertical distance from the center of water-pressure gauge to the center of pumps is 20.48 feet. From center of pumps to average level of water in pump well, during duty trial, was 14.4463 feet. From center of water-pressure gauge to B. M. in pump well was 18.000 feet.

For duty trial the following data were taken:

Steam pressure at boiler	every 15 minutes.
" " " engine	" 15 "
Water pressure	" 15 "
Engine counter	" 15 "
Level of water in boiler	" 15 "
Vacuum in condenser	" 30 "
Level of water below B. M.—in pump well	" 30 "
Temperature of feed-water to boilers	" 30 "
" " injection to condenser	hourly.
" " overflow from air-pumps	every 30 minutes.
" " air in engine room	hourly.
Indicator diagrams from steam cylinders	"
Barometer	"

The coal burned was "Lackawanna," of good quality. This was weighed in uniform charges of 70 pounds, on an acceptable scale in the boiler room, at the rate of two charges an hour, and dumped, just previous to firing, in front of the boiler; only one charge at a time being allowed upon the floor.

The fire was worked right and left; 70 pounds to a charge, every 30 minutes.

At 11 A. M., March 9th, the half fire to the right received the first full charge of 70 pounds; at 11.30 A. M., the half fire to the left received the second full charge of 70 pounds. At 12 M., the half fire to the right received the third full charge of 70 pounds; at 12.30 P. M., the half fire to the left received the fourth full charge of 70 pounds, and in like manner throughout the trial, the half fires right and left being alternately fired with regular intervals of 30 minutes between the firings.

At 5.15 A. M., March 10th, an extra charge was divided between the right and left side of fire; at 10.45 A. M., an extra charge was divided between the two sides of fire.

The trial for duty commenced at 11 A. M., March 9th, and ended at 11 A. M., March 10th, embracing an uninterrupted operation of the engine, under nearly uniform conditions of steam pressure, water pressure and speed—for a period of 24 hours.

During this time the coal fired was 50 charges of 70 pounds, or a total consumption of 3,500 pounds. Ash, clinker, and waste from ash-pit, at end of trial, 158.5 pounds. Percentage of non-combustible, 4.53 pounds.

The grate-bars were of the rocker pattern, and these were worked frequently to clear the fire of clinker and ash during the trial. The fires were cleaned of ash and clinker at beginning of trial, and the ash-pit raked clean. The fires were of the same thickness and in same condition, as nearly as could be judged from careful observation, at beginning and end of trial. The condition and thickness at beginning was observed and entered in the writer's notes at the time, and the same condition and thickness was restored at the end of trial.

The average head pumped against during the trial was 59.8384 pounds, obtained as follows:

Average pressure by water-pressure gauge	42.7057 pounds.
Correction of gauge	1.0000 "
Corrected gauge pressure	43.7057 "
Center of water-pressure gauge to bench mark	18.0 feet.
B. M. to surface, water in well	16.9263 "
Pressure due different levels	15.1327 pounds.
Add allowance for frictional resistance of pumps	1.000 "
Total head	59.8384 "
" "	138.106 feet.
Engine counter, 11 A. M., March 9th	149,986
" " 11 A. M., " 10th	188,188
Revolutions in 24 hours	38,202
" per minute	26.5292
Piston speed, per minute, feet	132.407

Area of plungers, (each)

$$20.03125^2 \times 0.7854 = 315.1425 \text{ square inches.}$$

Plunger travel, per revolution of engine,

$$\frac{29.96875 + 29.922}{12} = 4.991 \text{ feet.}$$

And duty developed, per 100 pounds of coal,

$$\frac{315.1425 \times 4.991 \times 59.8384 \times 38202}{35.00} = 102{,}728{,}884.96 \text{ ft. lbs.}$$

The specification and agreement guaranteed a duty of 95,000,000 foot pounds per 100 of coal burned, which was exceeded in the actual performance of the engine by nearly *eight millions* foot pounds.

The means of the data taken during the duty trial are as follows:

Duration of trial	24 hours.
Pressure of steam at boiler	72.062 pounds.
" " " " engine	71.287 "
Level of water in boiler, 11 A. M., March 9th	7.00 inches.
" " " " " 11 A. M., " 10th	6.875 "
" " " " " mean for trial	7.0332 "

Vacuum in condenser, observed	25.863 inches.
" " " corrected	24.345 "
" " " "	11.951 pounds.
Temperature of feed-water, observed	171.344
" " " " corrected	168.344
" " injection, observed	50.937
" " " corrected	49.937
" " overflow, observed	93.156
" " " corrected	91.656
" " air, engine room	73.23
Barometer, inches	29.466
" pounds	14.465

It was provided by the specification and agreement, that the engines hould have a capacity of 3,000,000 United States standard gallons per diem of 24 hours, at a piston speed of 130 feet per minute.

No provision was made in the contract for the measurement of the delivery of the pumps; neither were the connections of the pumps with the source of supply and the distributing mains such that an accurate measurement of the delivery could have been made, except with a discontinuance of water to the city for a period of several days.

In the absence of an exact measurement of the delivery of the pumps, which was not provided for by the contract, the writer measured the diameters and strokes of the pump plungers, from which to deduce the probable actual delivery at contract piston speed.

The pump plungers were carefully calipered, and measured upon a Brown & Sharp standard 24-inch steel scale, with results previously given in the table of dimensions. The stroke of plungers was measured by holding a finely pointed lead pencil firmly upon the upper surface of the lower cross-head (of each side of engine), which was machine faced, and causing it to inscribe the lineal movement of the pencil, and, by the same token, of the cross-head and connected plunger upon a dressed pine board held firmly down upon the top of pump-barrel and parallel with the axis of plunger, with the results previously given in the table of dimensions,

The total plunger stroke, per revolution of engine, was 59.89075 inches; and calculated capacity of both pumps, per revolution of engine, equal to one stroke of each pump, or two single strokes of plungers,

$$\frac{20.03125^2 \times 0.7854 \times 59.89075}{231} = 81.706 \text{ gallons.}$$

The pumps being of the single-acting variety, the effective area was therefore the full area due the diameters of plungers, or, 315.1425 square inches, and capacity of pumps, per diem of 24 hours, at a piston speed of 130 feet per minute,

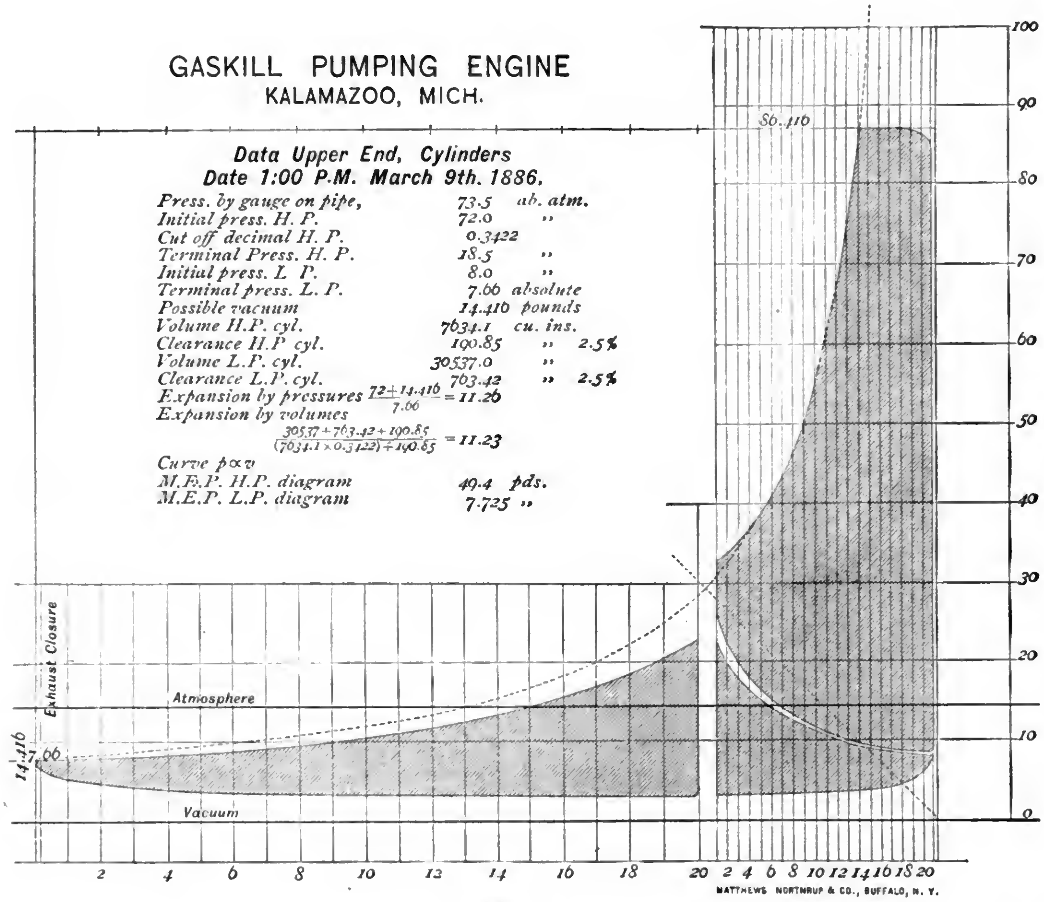


Fig. 3.

$$\frac{315.1425}{231} \times 12 \times 130 \times 1440 = 3{,}064{,}658.69$$

United States standard gallons.

The contractors' guaranteed capacity per diem, at 130 feet piston speed per minute, was 3,000,000 gallons. The calculated capacity of the pumps per diem, from measured dimensions and at 130 feet piston speed per minute, is 3,064,658.69 gallons, allowing 64,658.69 gallons, or 2.1098 per cent. of calculated capacity to cover the loss of action or slip of pumps.

Although this loss of action was less than the writer had ever obtained from comparison of calculated plunger, or piston displacements of pumps, with the actual measured deliveries, still it was not without precedent, as shown in the following test trials of pumping engines:

Simpson compound beam-rotative pumping engine, built by E. P. Allis & Co. for the City of Milwaukee, 1875, bucket and plunger pump:

Loss of action, 2.26 per cent.

Worthington compound, duplex, direct-acting pumping engine, built by H. R. Worthington for the City of Lowell, Mass., 1876, double-acting plunger pumps: Loss of action, 2.25 per cent.

Worthington compound, duplex, direct-acting pumping engine, built by H. R. Worthington for the City of Philadelphia, 1872, double-acting plunger pumps: Loss of action, 1.50 per cent.

Wm. Wright single cylinder, beam-crank and fly-wheel pumping engine, No. 1, Brooklyn Water Works bucket and plunger pump, from tests by Mr. Kirkwood, 1860: Loss of action, 2.0 per cent.

Wm. Wright single cylinder, beam-rotative pumping engine, No. 2, Brooklyn Water Works bucket and plunger pump, from tests by Mr. Kirkwood, 1860: Loss of action, 1.50 per cent.

Corliss compound crank and fly-wheel pumping engine, built by Corliss Steam Engine Co, for the City of Providence, R. I., 1882, single-acting plunger pumps: Loss of action, 0.50 per cent.

Mr. Colyer, in his "Treatise on Pumping Machinery," page 84, says: "The slip of single-acting plunger pumps, Cornish style, at the Southwark and Vauxhall Water Works, London, does not exceed 2 per cent. of the calculated displacement."

Although the least loss of action which the writer has ever measured is greater than any given in the table above, as follows:

Gaskill compound crank and fly-wheel pumping engine, Memphis, Tenn., 1882, double acting plunger pumps:

Engine No. 1. Loss of action, 2.43 per cent,
" No. 2. " " " 2.44 " "

he is of the opinion that the style of pumps furnished with this engine—with the packing around the plungers tight and pump valves in good condition—will work with a loss of action less than was found for the Memphis pumping engines with central packing rings, and that the allowance of 64,658.69 gallons per diem, in excess of the contract capacity of 3,000,000 gallons, will fairly cover the probable loss of action of the pumps, and that the contract requirements for capacity were fairly complied with.

It has been stated that the well from which the engine pumps, is supplied by infiltration from the surrounding soil, which passes into the well under the iron shoe upon which the curb is built.

(To be continued.)

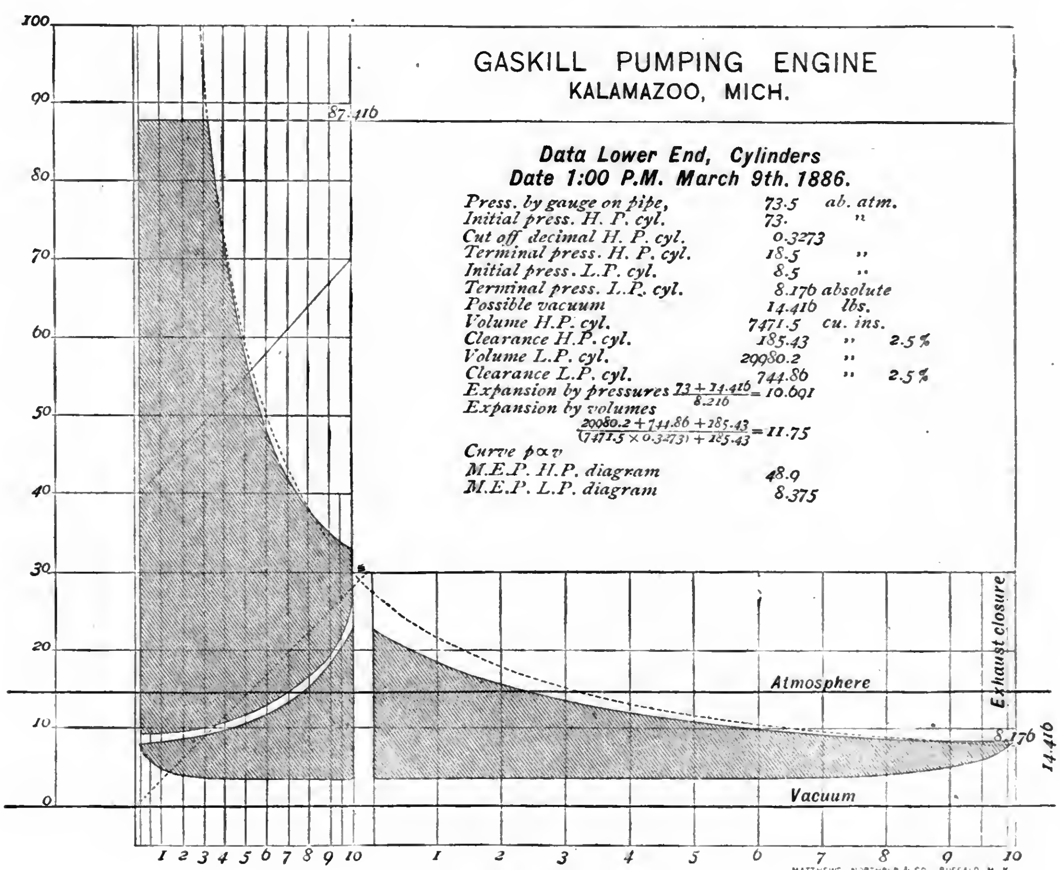


Fig. 4.

Locomotive Coupling-Rods.

THERE have been several letters published in English engineering papers, recently, containing testimony with reference to the first use of solid eyes and bushes on locomotive coupling-rods. The latest writer says: "The first coupled locomotive with *solid eyes and bored and turned bushes* I had seen, was made by the firm of Slaughter, Grunning & Co., of Bristol, turned out early in 1861, to the order of the Waterford & Tramore Railway Company, and it was considered a new departure at the time. Can some of your other correspondents give an earlier date?"

It may interest some of these correspondents to know that solid eyes and bushes were used in this country on Winans' camel engines as early as 1852. They are also shown in an old lithograph of a "grasshopper" locomotive built by Gillingham & Winans in 1835.

Is Water Gas an Economical Fuel?*

BY WILLIAM KENT, NEW YORK.

IN the discussion of Mr. F. W. Taylor's paper on water gas, at the Chicago meeting, the writer stated that the conclusion to which Mr. Taylor had been led by his experiments, viz.: that water gas is not as economical as Siemens gas, when used as a fuel for steel-melting furnaces, would probably be confirmed by a theoretical consideration of the amount of heat carried away in the chimney gases. A further study of the subject shows that the opinion then given was correct.

Let C represent the carbon in a given quantity of fuel.

O the oxygen needed to make carbonic oxide (CO) with this C.

2O the oxygen needed to make carbonic acid (CO_2) with the same C.

H_2O the water needed to make water gas of the formula (CO+2H) with the same C.

N the nitrogen in the air from which the O is taken to burn C to CO.

2N the nitrogen in the air from which the 2O is taken to burn C to CO_2.

Ex. air the excess of air used in final combustion in the furnace over that required to make complete combustion.

The fuel may be used in three ways:

1st, by direct and complete combustion in the furnace.

2d, by partial combustion in the Siemens gas producer, and final combustion of the Siemens gas in the furnace.

3d, by partial combustion in the water gas producer, and final combustion of the water gas.

The results of the three ways of burning the fuel are as follows:

	Materials used.	Products.
1. Direct.	C+2O+2N+Ex. air	CO_2+2N+Ex. air.
2. Siemens.	In producer, C+O+N	CO+N (Siemens gas).
	In furnace, CO+N+O+N+Ex. air.	CO_2+2N+Ex. air.
3. Water gas.	In producer, C+H_2O	CO+2H (Water gas).
	In furnace, CO+2H+2O+2N+Ex. air	CO_2+2N+Ex. air +H_2O.

The final product of (1) and (2) is the same. The final product of (3) differs from that of (1) and (2) only in containing H_2O, which is the same H_2O (water) which was added in the producer in making the gas. This is true whatever may be the actual formula of the water gas. All the water originally used in the manufacture of the gas reappears in the products of combustion in the chimney. The only difference is that in the chimney it appears in the form of steam, superheated to the temperature of the chimney gases, while it originally enters the system as cold water. All the heat contained in the water thus escaping in the chimney, above the amount it contained when it was originally introduced into the system, is entirely wasted.

The amount of heat thus wasted can be calculated if we know the amount of water used, and its temperature on entering and on leaving the system.

Suppose a pure water gas to be of the formula

CO+H made from C+H_2O
or, pounds, 12+16+2 12+18

The escaping gases would contain, in addition to nitrogen and excess of air,

CO_2+H_2O
pounds, 44+18.

The 18 pounds of water being the same from which the water gas was made with 12 pounds carbon. The carbon, if completely burned from C to CO_2, would generate 12 x 14,500 = 174,000 heat units (Fahrenheit). Suppose that the chimney gases are cooled by regenerators or other means down to 212° F., that the water escapes in the form of steam of that temperature—its total heat, including latent heat of evaporation, being 1,178° F.—and that the water entered the system at 78° F. The heat carried away by this water escaping in the shape of steam, in excess of that which it introduced into the system, would be

1,100 x 18=19,800 heat units,

equal to about 11.4 per cent. of the whole amount of heat produced by burning the 12 pounds carbon from C to CO_2.

This is the most favorable case, for it is in practice never possible to cool the chimney gases of heating furnaces to as low a temperature as 212° F.

Theoretical considerations, therefore, indicate a loss of economy in the use of water gas as fuel, equal to at least 11 per cent. of the total fuel value of the carbon used, and this, independent of any loss which may arise from imperfections of the producer or its method of operation.

Such a loss is not met with in the Siemens system, nor in the ordinary system of direct burning of the fuel upon a grate, except in so far as moisture in the shape of cold water may be present in the fuel used.

The fact that there is a loss of economy in the use of water gas as a fuel, in comparison with the direct use of the carbon from which it is made, is clearly revealed in other ways, however, even by some of those who have written in favor of the water-gas processes. For instance, Dr. Henry Wurtz, in Vol. VIII "Trans. Amer. Inst. Mining Engineers," pp. 295, 296, shows that 37.5 pounds of anthracite coal are required to generate 1,000 cubic feet of water gas, and that water gas has a heating power of 311° F. per cubic foot. This equals 311,000 heat units per 1,000 cubic feet. Assuming anthracite to produce 13,000 heat units per pound (a moderate figure), the 37.5 pounds, if burned directly, would produce 13,000 x 37.5= 487,500 heat units, showing that the water gas has a thermic value of only 63.8 per cent. of the coal from which it is produced.

Better results are deduced theoretically by Mr. Wm. A. Goodyear, Vol. XI "Trans. Amer. Inst. Mining Engineers," p. 311. He shows that water gas derived from anthracite has about 81 per cent. of the heat-producing power of the carbon contained in the anthracite. Neither of the two writers named, however, seem to have considered the cause of the loss of heat to which I have referred, viz.: the carrying away of heat in the superheated steam in the chimney gases.

* Paper read before the American Society of Mechanical Engineers.

Improvements in Locomotives and Signals.

AT the opening meeting of the session, held on November 9th, Mr. Edward Woods, president, delivered an address, in which he stated that his connection with the profession dated from the time when he entered the service of the Liverpool & Manchester Railway Company. After describing the system on which that line was originally constructed and the improvements subsequently introduced, he observed that, generally, the substitution

of steel for iron rails had been attended with most beneficial results to all railway companies, a change which was rendered possible by the inventions of Sir Henry Bessemer and Sir William Siemens, and the keen competition of manufacturers. The president then proceeded to remark that the most advanced type of locomotives of the present day retained the essential characteristics of those which held the field at the commencement of the era to which he had referred. Great improvements, it was true, had been effected in most, if not in all, constructive details, while the progressive increase of traffic called for a corresponding augmentation of the power necessary to haul the trains. Hence the locomotives of the present day possessed, as a rule, at least four times more steaming power, coupled with six-fold weight, than those of the class represented by the "Planet," the approved type of the period from 1832 to 1836. The contrast in point of efficiency, between the locomotives of the present period and those of half a century ago, was striking. As to tractive power, the increase was at least fivefold, having regard to the proportions of the parts, the steaming capacity of the boilers, and the higher pressures of steam at which the engine was now worked. Inclines which at one time were regarded as too formidable to be worked advantageously by locomotives, were now readily surmounted by the powerful engines of the present day. The limit of inclination admitting of being surmounted by locomotives appeared to be practically reached at the figure of about 264 feet to the mile (one in 20). Where the incline was greater, resort must be had either to the stationary engine and rope, or to one of the systems which had recently been reintroduced. Concurrently with the increase of traffic, the increased speed at which it had to be conducted, and the increased number of trains rendered it necessary to provide fresh agencies. Distant signals were unknown at first, as well as the appliances for controlling them from the home signalman's station. Still later, it became possible to actuate all the switches opening into the sidings and cross-roads of a station from a central signal-box, supplemented afterwards by the admirable arrangements for interlocking, and the simultaneous control of signals as depending on the altered positions of those switches. Then the invention of the electric telegraph enabled instant communication between station and station, and afterwards the establishment of the block system, which, when carried out properly, would seem to have reduced the chances of collision to a *minimum* so far as signaling was concerned.

Torpedo Experiments.

(From the *London Times*.)

THE torpedo experiments against the *Resistance*, armor-plated ship, moored fore and aft in Fareham Creek, Portsmouth, reached the culminating point this afternoon (November 2d), the attack having suddenly approached, at a bound, from a range of 25 feet to actual contact with the ship. The interest aroused by the experiment was greater than on any previous occasion, as nothing less was expected than that the veteran ironclad would receive its quietus, and be either blown to pieces or sunk. It was also the first time that a real *Whitehead* had been exploded in actual contact with a real ship of war, and it was hoped that much information would result, not only as regarded the destructive effects of the engines fired at close quarters, but with respect to the value of double bottoms and coal bunkers in circumventing the effects of the burst, and the importance of water-tight bulkheads in localizing the inrush of water. The result proved another disappointment for the attack, in spite of the considerable injury that was inflicted. As a matter of fact, the ship was placed under every disadvantage, while everything was done to add to and aggravate the power of the assault. The *Resistance* was placed in chancery, so to speak. She was deprived of her net defenses and moored in shallow water, while a 16-inch torpedo, charged with 93 pounds of gun-cotton, was lashed to a boom and placed longitudinally, fore and aft, in contact with the port side of the hulk amidships. The submersion was about eight feet, which brought the torpedo immediately above the bilge keel. It was not, however, supposed that there would be any overhang or bulge of the ship beyond 18 inches. At 20 minutes past 3, the torpedo was exploded upon a falling tide. The shock was not greater than in previous experiments, and the amount of water thrown up not unusual. So far as sensation was concerned, the effect was tame and disappointing, for the simple reason that something extraordinary was counted upon. The ship was thrown slightly to starboard by the energy of the explosion, after which she slowly listed to port, but not much. It was evident that her bottom had been damaged, and that, notwithstanding the application of a collision mat, water was finding ingress—in fact, the mat was useless, as there was no rush of water to force it into the rents. As an observation of the water-line showed that the ship, after heeling over to a definite angle, remained stable, it was supposed that she had touched bottom and that she would inevitably have sunk had she been moored in deep water, but subsequent investigation proved that she was still afloat and could have been brought into harbor, had such been required. The bilge keel had been shaken off and broken to the extent of 20 feet, while the plating below was very much indented. Above the bilge keel three or four strakes of the skin plating, extending up to the armor belt, had also been forced inward where they crossed the longitudinal frames. They had parted in the middle to the length of 8 feet, while some of the butts had been opened, so that gashes, two and three inches wide, appeared at the junction. There were also a few holes observable in various parts. Internally the skylights had been smashed, and the contents of the bunkers scattered in all directions. The exact amount of the damage done inside will only be accurately known after the ship has been docked. But what is of greatest importance is the fact that the water-tight bulkheads remained intact, and, by confining the water to one compartment, sufficed to keep the *Resistance* afloat and capable of fighting her guns. Indeed, there is no resisting the impression from these experiments that the value of the *Whitehead* has been greatly exaggerated. The torpedo cannot get through the steel protective nets, and when it dashes itself against them and explodes, the consequence is *nil*, at a distance of 25 feet. It also remains to be mentioned that the test to-day was scarcely a practical one, as the fixity of the missile against the side of the ship did not allow for its rebound before bursting. The comparative effect of the rebound of a *Whitehead* striking at a great speed ought to be determined, and also the consequence of the burst upon the boilers and steam pipes of the *Resistance* under a working pressure of steam.

Commenting on the above the *Times* says, editorially: A very important experiment in the modern art of naval

warfare was carried out yesterday in Portsmouth Harbor, by the explosion of a *Whitehead* torpedo in actual contact with the bottom of a ship of war. A full account of the proceedings will be found in another column. The ship submitted to the experiment was the *Resistance*, an obsolete ironclad, which has already been made the subject of a series of experiments, both with artillery and submarine explosives. The interior of the vessel had been prepared so as to represent the modern arrangements of coal defense, for the protection against submarine attack of those portions of a vessel's hull which are not covered by a defensive armor. A 16-inch *Whitehead* torpedo, charged with 93 pounds of gun-cotton, was lashed to a boom and placed longitudinally in contact with the ship's side, immediately above the bilge keel, about 8 feet below the surface of the water. In this position the torpedo was exploded, and, as compared with the anticipations formed of its destructive effects, the result was singularly disappointing. A considerable portion of the external plating of the ship was forced inward and displaced, leaving gaps and gashes through which the water could pass. Internally, the skylights were smashed, and the contents of the bunkers containing the coal defense were scattered in all directions. But the ship was not sunk, as had been expected, and the water-tight bulkheads remained intact, so that if she had been in action, she could have kept afloat and continued to fire her guns, and could have been brought into harbor for repairs. Every advantage was given to the torpedo. The vessel was stationary, and the torpedo was leisurely attached in a position adapted to give it the *maximum* of destructive power. In actual warfare, the torpedo would have to strike the vessel with its point, and a certain amount of rebound would take place before the explosion could occur. It should, however, be noticed that, as our Portsmouth correspondent further points out, we can draw no inference either from the experiment of yesterday, or from those which preceded it, concerning the possible effects of a torpedo explosion on the boilers and steam-pipes of a vessel actually under steam at the moment of attack.

Yesterday's experiment is of great importance, if only as being the first instance in which a real *Whitehead* torpedo has been exploded in actual contact with a real ship of war. It is not, of course, entirely conclusive, for the reasons we have briefly given above; but, taken in connection with the experiments previously made on the *Resistance*, it furnishes a rough measure of the offensive capacities of the torpedo. Those capacities are evidently not so great as has often been supposed. Admiral Mayne stated lately, in the House of Commons, that his recent experience with the Channel Fleet had led him to think that the value of torpedoes against ships of war had been very greatly exaggerated. The late Hobart Pasha drew a similar inference from his actual experience in the Russo-Turkish war. The only practical result of the use of torpedoes in that war, was to furnish the Turkish government gratuitously with a secret which many other governments had purchased at a great price. A torpedo launched by a Russian vessel against the Turkish fleet at Batoum, was diverted by a stockade erected by Hobart Pasha for the purpose, and went harmlessly ashore. The Turkish authorities thus came into possession of the secret of its mechanism, and were enabled to make their own terms with the manufacturer. The opinion of Admiral Mayne and the conclusions of Hobart Pasha have now been corroborated by the experiments at Portsmouth. The problem of torpedo attack and defense divides itself into two main branches, according as the vessel attacked is stationary or in motion. A vessel at anchor anticipating attack is now protected by steel wire netting of a peculiar make specially adapted for the purpose. This netting is suspended from booms rigged out from the ship's side so as to form a sort of crinoline, completely enveloping the ship from the level of the water-line to a depth corresponding to the submersion of the vessel. It is very important to determine the *minimum* distance from the ship's side at which the torpedo netting will afford secure protection against torpedo attack, because the weight, and still more, the leverage of the booms, and by consequence, the difficulty of fixing them and maintaining them in position, increase with every increase of their length. To this object, the first series of experiments conducted with the *Resistance* was directed. In the first instance, the nets were boomed out to a distance of 30 feet, and the Whitehead torpedo was fired against them. The ship was entirely uninjured by this attack. The nearest boom was unshipped from its support, but all the others remained intact. The meshes in the immediate neighborhood of the actual explosion were carried away, but the area of positive destruction was so exceedingly limited that a second discharge would have proved just as harmless as the first, unless it happened to pass through the rent in the defenses inflicted by the first. Subsequent explosions were effected at distances of 25 feet, of 20 feet and of 15 feet. At 25 feet, no serious damage was done. At 20 feet, on one occasion, the ship was found to be leaking in consequence of the fracture of one of the valves; and similar effects, though considerably more serious in character, were produced by the explosion at 15 feet. Finally, a torpedo was launched against netting suspended at a distance of 25 feet from the ship. In this case the vessel itself, though severely shaken at the moment of explosion, was not materially nor permanently injured, though the rear boom in the wake of the point aimed at was blown away from its hook,—a result which was held to demonstrate the weakness of the existing hinge arrangement. The net result of this series of experiments seems to be that a stationary ship can be effectively protected against torpedo attack by wire netting properly secured at the extremities of booms of a *maximum* length of 25 feet. For practical purposes, it may possibly be found safe to reduce the length of the booms somewhat further, the line of complete security evidently lying somewhere between 15 feet and 25 feet, and somewhat nearer to the superior than to the inferior limit.

For a vessel in motion, on the other hand, protection by means of wire netting seems to be impracticable. Even if it could be permanently kept in position, the netting would seriously reduce the speed of the ship and impair its handiness in manœuvering. Accordingly, it has hitherto been supposed that a ship in motion would have to trust very much to chance for security against torpedo attack, to the difficulty of taking accurate aim with the torpedo against a moving object—a difficulty practically illustrated by the failure of the *Shah* to hit the *Huascar* with her torpedoes—and to the element of uncertainty which, in spite of all attempts to correct it, still attaches to the path of a torpedo through the water. But it has been very generally assumed that if a torpedo could, at any time, manage to hit a moving ship fairly and squarely, and to explode under these circumstances,

the ship would inevitably be sent to the bottom. If it does nothing else, yesterday's experiment overthrows this assumption. A torpedo has been exploded in actual contact with the unarmored part of the bottom of the *Resistance*, and though the vessel was seriously injured and her plates were started, bulged and rent, she remained afloat; she could still have fired her guns, and was sufficiently seaworthy to have made her way to an adjacent harbor. The crucial result of the experiment is, that the water-tight bulkheads remained intact. We call it a crucial result because naval constructors have mainly relied on a system of subdivision, by means of water-tight bulkheads, for defense against torpedo attack. The theory, of course, is, that so long as the bulkheads remain intact, without rent or leak, the water may be freely admitted into one compartment—or even more, up to a certain definite limit—without causing the ship to sink. Now, this is, so far, mainly a matter of calculation. A naval constructor knows, or ought to know, how many of the water-tight compartments can be filled with water without danger to the ship; but, in default of actual experiment, he cannot determine with certainty the capacity of the bulkheads to resist the effects of concussion. If the torpedo makes a rent in the outer skin of the ship, the water, of course, enters into the compartment laid open by the explosion; but, so long as the bulkheads remain intact, that is a contingency already provided for. Of course the damage is serious, but ships cannot expect to escape unscathed when they go into action. On the other hand, it is not fatal; it is a damage that can be repaired, and, in the meanwhile, it does not paralyze the fighting power of the ship, nor expose her to inevitable capture or destruction. At a single stroke, therefore, the torpedo has lost half its terrors. It is no longer the unseen and insidious enemy which can send a ship to the bottom whenever it can strike the blow. It is formidable, but not irresistible. Its moral terrors will quickly evaporate as soon as its offensive powers are shown to be no more certainly fatal than those of other modern weapons of warfare. At a distance of 25 feet its attacks against a stationary vessel can be completely neutralized. Its explosion in actual contact with the ship leaves her floating and seaworthy, with her offensive powers not materially impaired. If these conclusions, which are provisional and tentative as yet, are corroborated and established by further experiments, a very material change will be effected in the theory and practice of naval warfare.

Accidents on British Railroads.

Summary of Accidents and Casualties which have been reported to the Board of Trade as having occurred upon the Railways in the United Kingdom during the Six Months ending 30th June, 1886.

I. ACCIDENTS TO TRAINS, ROLLING-STOCK, PERMANENT WAY, &C.

ACCIDENTS to trains, rolling-stock, permanent way, &c. caused the death of 11 persons, and injury to 364, viz.:

	Killed.	Injured.	Total for the corresponding period in 1885. Killed.	Injured.
Passengers............	8	324	5	175
Servants of companies..	3	40	4	25
Total..........	11	364	9	200

During the six months there were reported 24 collisions between passenger trains or parts of passenger trains, by which 1 passenger was killed, and 191 passengers and 15 servants were injured; 19 collisions between passenger trains and goods or mineral trains, &c., by which 1 servant was killed, and 36 passengers and 8 servants were injured; 7 collisions between goods trains or parts of goods trains, by which 2 servants were killed, and 12 were injured; 30 cases of passenger trains or parts of passenger trains leaving the rails, by which 6 passengers were killed, and 40 passengers and 4 servants were injured; 2 cases of trains traveling in the wrong direction through points, by which 1 servant was injured; 7 cases of trains running into stations or sidings at too high a speed, by which 34 passengers were injured; 158 failures of axles, by which 2 passengers were injured; and 2 failures of couplings, by which 1 passenger was killed and 21 were injured.

The following cases were also reported, but they involved no personal injury: 1 case of a train coming in contact with a projection from a wagon; 1 case in which part of a goods train left the rails; 54 cases of trains running over cattle* or other obstructions on the line; 19 cases of trains running through gates at level crossings; 2 failures of engine machinery; 411 failures of tires; 123 broken rails; 14 floodings of the permanent way; 12 slips in cuttings or embankments; 4 fires in trains; 3 fires at stations or involving injury to bridges or viaducts; and 1 other accident.

Of the 411 tires which failed, 9 were engine tires, 1 was a tender tire, 11 were carriage tires, 7 were van tires, and 383 were wagon tires; of the wagons, 288 belonged to owners other than the railway companies; 349 tires were made of iron, 60 of steel, and in 2 cases the material was not stated; 12 of the tires were fastened to their wheels by Gibson's patent method, and 12 by Mansell's, none of which left their wheels when they failed; 3 by Beattie's patent method, one of which left its wheel when it failed; 381 by bolts or rivets, 4 of which left their wheels when they failed; and 3 by other methods, one of which left its wheel when it failed; 28 tires broke at rivet-holes, 6 at the weld, 64 in the solid, and 313 split longitudinally, or bulged.

Of the 158 axles which failed, 95 were engine axles, viz., 84 crank or driving, and 11 leading or trailing; 11 were tender axles, 1 was a carriage axle, 46 were wagon axles, and 5 were salt-van axles. 21 wagons, including the salt-vans, belonged to owners other than the railway companies. Of the 84 crank or driving axles, 59 were made of iron and 25 of steel. The average mileage of 56 crank or driving axles made of iron was 229,882 miles, and of 25 crank or driving axles, made of steel, 219,198 miles.

Of the 123 rails which broke, 59 were double-headed, 63 were single-headed, and 1 was of the bridge pattern; of the double-headed rails, 38 had been turned; 21 rails were made of iron, and 102 of steel.

II. ACCIDENTS TO PASSENGERS FROM CAUSES OTHER THAN ACCIDENTS TO TRAINS, ROLLING-STOCK, PERMANENT WAY, &C., INCLUDING ACCIDENTS FROM THEIR OWN WANT OF CAUTION OR MISCONDUCT; ACCIDENTS TO PERSONS PASSING OVER LEVEL-CROSSINGS; TRESPASSERS; AND OTHERS.

Of the 239 persons killed and 404 injured in this division, 43 of the killed and 303 of the injured were passengers. Of the latter, 9 were killed and 19 injured by falling between carriages and platforms, viz., 7 killed and 10

* During the six months 8 horses, 1 pony, 23 beasts and cows, 45 sheep, and 4 donkeys were run over and killed.

injured when getting into, and 2 killed and 9 injured when alighting from trains; 3 were killed and 210 were injured by falling on to platforms, ballast, &c.. viz., 31 injured when getting into, and 3 killed and 179 injured when alighting from trains; 14 were killed and 10 injured whilst passing over the line at stations; 27 were injured by the closing of carriage doors; 5 were killed and 6 injured by falling out of carriages during the traveling of trains; and 12 were killed and 31 injured from other causes. 39 persons were killed and 17 injured whilst passing over railways at level-crossings, viz., 23 killed and 14 injured at public level-crossings, 9 killed and 2 injured at occupation crossings, and 7 killed and 1 injured at foot-crossings. 97 persons were killed and 42 injured when trespassing on the railways; 37 persons committed suicide on railways; and of other persons not specifically classed, but mostly private people having business on the companies' premises, 23 were killed and 42 injured.

III. ACCIDENTS TO SERVANTS IN THE EMPLOY OF RAILWAY COMPANIES OR CONTRACTORS, CAUSED BY THE TRAVELING OF TRAINS OR THE MOVEMENT OF VEHICLES USED EXCLUSIVELY UPON RAILWAYS.

During the six months there were 199 servants of companies or contractors reported as having been killed and 918 injured, in addition to those included in Division I. Of these 15 were killed and 152 injured whilst coupling or uncoupling vehicles; 2 were killed and 12 injured by coming in contact, whilst riding on vehicles during shunting, with other vehicles, &c., standing on adjacent lines; 12 were injured whilst passing over or standing upon buffers during shunting; 9 were killed and 80 injured in getting on or off, or by falling off engines, wagons, &c., during shunting; 4 were killed and 72 injured whilst breaking, spragging, or chocking wheels; 3 were killed and 16 injured whilst attending to ground points, marshaling trains, &c.; 3 were killed and 83 injured whilst moving vehicles by capstans, turntables, props, &c., during shunting, and 22 were killed and 152 injured by various other accidents during shunting operations; 5 were killed and 21 injured by falling off engines, &c., during the traveling of trains; 4 were killed and 9 injured by coming in contact with over-bridges or erections on the sides of the line during the traveling of trains; 11 were killed and 61 injured whilst getting on or off engines, vans, &c., during the traveling of trains; 1 was killed and 52 were injured whilst attending to, or by the failure of machinery, &c., of engines in steam; 42 were killed and 53 injured whilst working on the permanent way, sidings, &c.; 2 were killed and 1 was injured whilst attending to level-crossing gates; 34 were killed and 45 injured whilst walking, crossing or standing on the line on duty; 8 were killed and 20 injured by being caught between vehicles; 6 were killed and 11 injured by falling or being caught between trains and platforms, walls, &c.; 27 were killed and 9 injured whilst walking, &c., on the line on the way home or to work; and 1 was killed and 57 were injured from various other causes.

Altogether, the number of persons killed and injured on railways in the United Kingdom in the course of public traffic, during the six months ending 30th of June, 1886, as reported to the Board of Trade, was as follows:

	Killed.	Injured.	Total for the corresponding period in 1885. Killed.	Injured.
Passengers:				
From accidents to trains, rolling-stock, permanent way, &c....	8	324	5	175
By accidents from other causes.	43	303	35	295
Servants of companies or contractors:				
From accidents to trains, rolling-stock, permanent way, &c....	3	40	4	25
By accidents from other causes.	199	918	208	944
Persons passing over railways at level-crossings..............	39	17	30	7
Trespassers (including suicides).	134	42	133	50
Other persons not coming in above classification..........	23	42	20	36
Total..............	449	1,686	435	1,532

Note.—In addition to the above, the railway companies have reported to the Board of Trade, in pursuance of the 6th Section of the Regulation of Railways Act, 1871, the following accidents which occurred upon their premises, but in which the movement of vehicles used exclusively upon railways was not concerned, namely: 55 passengers injured whilst ascending or descending steps at stations; 18 injured by being struck by barrows, falling over packages, &c., on station platforms; 12 injured by falling off platforms; and 19 injured from other causes. Of servants of companies or contractors, 3 killed and 464 injured whilst loading, unloading, or sheeting wagons; 141 injured whilst moving or carrying goods in warehouses, &c.; 2 killed and 79 injured whilst working at cranes or capstans; 1 killed and 77 injured by the falling of wagon-doors, lamps, bales of goods, &c.; 156 injured by falling off, or when getting on or off, stationary engines or vehicles; 7 killed and 85 injured by falling off platforms, ladders, scaffolds, &c.; 109 injured by stumbling whilst walking on the line or platforms; 114 injured whilst attending to stationary engines in sheds; 23 injured by being trampled on or kicked by horses; 2 killed and 262 injured whilst working on the line or in sidings; and 97 injured from various other causes. Of other persons, most of whom were transacting business on the companies' premises, 4 were killed, and 62 injured—making a total in this class of accidents of 19 persons killed and 1,773 injured.

Thus, the total number of personal accidents reported to the Board of Trade by the several railway companies during the six months amounts to 468 persons killed and 3,459 injured.

On the Remarkable Effects of Adding Saccharine Matter to Mortars.

BY SAMUEL CROMPTON.

(From *The Engineer*.)

A letter from Mr. Thomson Hankey "On a New Use of Sugar"—*Times*, October 13—has given rise to wide discussion and inquiry. At a time when the price of sugar is so low, and, as I shall show, when the use of a very small quantity of it, or of treacle, adds largely to the strength of mortar, and makes Portland cement itself set with great rapidity, it seems to me that I may do a service to engineers by laying before them the scientific grounds on which I was led to experiment on the subject, and the remarkable results which have been obtained.

The practical importance of this addition of saccharine matter to mortar I will state briefly, to begin with, and will give a few illustrations:

I mixed in a small jar some Portland cement and brown sugar, adding water, and stirring. I took out a little of the cement for an experiment, and when I tried an hour after to take out more, I found that the remainder had already set.

My neighbor, Mr. Rowland, weighed carefully Portland cement and sand into four small jars. To two he added different sugars, to the third treacle, but to the fourth no saccharine matter. On the following day the cement had set—we do not know how much earlier, for it was not examined—in all the jars with saccharine matter. Mr. Holden, Jr., the foreman of a builder, examined all of them on the Monday following the Friday on which they had been mixed. On pressing the cement to which the treacle had been added, he said: "I might press the bottom of the jar out before I can make impression on this." He then put his finger into the jar in which there was no saccharine matter, and stirred up the cement which had not set at all, and which did not set till a day or two after. It may be objected that it might not be an advantage that it should set so quickly. This objection will be answered by-and-by as I proceed, by showing that it is highly probable that the strength of Portland cement will be greatly increased by this addition of saccharine matter.

Mr. Thomson Hankey had experiments made, first by his own brickmaker and secondly by a housebuilder. Both reported that the addition of sugar made a common lime equal to Portland cement,

The bearing of these facts will be plain to every engineer, but I cannot forbear mentioning here a startling incident. The Ecclesiastical Commissioners built for the late Bishop Fraser, of Manchester, on his coming into the diocese, a lodge like that at Lambeth, with a lofty archway set in Portland cement. A clerk of the works appointed by the architect of the commissioners superintended it. After a due time the scaffolding was removed. One day—perhaps that day—the bishop walked through and had just got beyond danger, when the whole of the archway fell. If he had been under it he would have been killed, and his grand career as a bishop would have been cut short at the outset. Your readers, as I proceed with my statement, will judge for themselves whether the addition of a few shillings-worth of treacle would not have made all secure, and have saved the expense of doing this work over again.

hav to exp. in how it is that sugar, or rather saccharine matter of any kind, produces this remarkable effect on lime. Here I ought to mention that I am a retired physician, and that the idea of putting the matter to the proof arose in the following manner: In medicine we have two kinds of lime water, one the common lime water that can be got by mixing lime and water. It is to be particularly noted that, add as much lime as you like, it is impossible to get water to dissolve more than half a grain of lime in one ounce, or about two small tablespoonfuls of water. But by adding two parts of white sugar to one part of lime, we obtain a solution containing about 14½ times more lime in the same quantity of water. Here it is to be observed—and it is a most important point—that there are hot limes, such as Buxton lime, which, if the sugar be incautiously mixed with them, will *burn* the sugar, make it a deep brown color, and convert it into other chemical forms, and possibly, and I think probably, will destroy its value in mortar. The way to use sugar with such limes is to dissolve it first in the water. I dwell particularly upon this because a gentleman referred to me by Mr. Thomson Hankey, in writing to thank me for the information I had given him, casually observed that his cement had turned nearly black by the addition of the sugar. Probably many other experimenters with sugar and hot limes have had the same result, and are in the belief that all is right. Our strong medical saccharated lime water looks like water.

Ten or fifteen years ago I had been experimenting with lime and sugar, but not in reference to mortar, and I spoke about that time to my friend, the late E. W. Binney, F. R. S., about this property of sugar. He said that it was very curious, and that it was new to him; and he told me this anecdote, that in his grandfather's time an Italian architect came down to Worksop to erect a building for a nobleman, and insisted on being supplied with malt to make his mortar with. The malt was supplied and used. Many years afterwards this building had to be taken down; but, said Binney, "they could not pull it down, do what they would, and they had to use gunpowder." I said it would be the saccharine matter in the malt that produced this result. He agreed with me.

A few months ago I was at Peterborough, and went to see the progress of the restoration of the cathedral, where I made the acquaintance of Mr. Irvine, Mr. Pearson's clerk of the works. Mr. Irvine was for more than a quarter of a century with Sir Gilbert Scott, and possesses a greater knowledge of architecture, and antiquity bearing on English architecture, than any one I ever met with. One day I said to him that I had been to Fotheringay. He replied that he had seen every other church than that in the neighborhood of Peterborough. I asked him to go with me on his Saturday's half-holiday, as my visit to the church had been a hurried one, and I wished to make some further inquiries. Besides, I was glad to have the companionship of one who was so thorough a master of the subject. The chancel of this fine church, built before the nave, and so late as 1410, has entirely perished; and it had been so badly built that even in the time of Queen Elizabeth it had fallen in and was then in ruins. The chancel and tower exist, but the tower is unsafe, and if the church be not soon restored this grand historical monument may suffer or be destroyed. As Mr. Irvine and I walked to the railway station, I asked him whether he was aware of the chemical fact that the addition of sugar to water makes it take up about sixteen times more lime than water by itself does—I might have said a little more than fourteen times. He replied that he did not know this fact, and that he had never heard of it, and that he did not believe that it had been so used in mortars. I then told him what Mr. Binney had told me regarding the building erected by the Italian architect near Worksop. He said that he had been clerk of the works in the restoration of several cathedrals, in the books of which he had met with old entries of payments "For beer for the masons," and that he had found one entry where it was written, "For beer to mix with the mortar." said that that would be for the saccharine matter in it; and I added that a few years ago I had seen in a newspaper that the vintage in Spain had been so abundant that the people had not casks enough, and were using the wine to mix with their mortar. It flashed across my mind that this traditional use of saccharine matter was probably the explanation of the exceptional hardness of the old Roman mortar, and had been handed down from generation to generation, and had at length been forgotten, in England

at any rate. A few days afterwards I was pondering as I walked along the street in Peterborough on this matter, when suddenly I said to myself, "Why not try the experiment?" I went into a grocer's shop and bought a pound of exceedingly finely powdered loaf sugar and some beeswax—of the wax I will speak some other time. I took the sugar to the hut in the cathedral yard, where I found the foreman of the contractor and Mr. Irvine. Laughing, I said, "I have come to teach you to suck eggs." After explaining to the intelligent foreman my views, he and Mr. Irvine kindly agreed to try the experiment. Some powdered lias lime and some of the sugar were being mixed together in an iron basin. Water was added, and Mr. Irvine began to stir them with a trowel. No sooner had he done so than he exclaimed, "Look, look! It is beginning to set already." I said, "Is not that usual?" He replied, "No; something very uncommon." The mortar was poured out on the end of a beam, where it set. Some more was then made, much thinner, and a little sand added to it. With this, which was about the consistency of cream, two large fragments of the broken stone tracery of an old window were joined, and so were two bricks, two pieces of glass, and two slates. It would be about five o'clock in the evening. As I was going to leave Peterborough about noon on the following day, I called at the cathedral about ten in the morning to see the results. Mr. Irvine said it was too early to judge. He felt at the stone tracery very tenderly. Holding the upper fragment, he then tilted the tracery sideways, and as the stones held together, he then took hold of the upper fragment with both hands and lifted the whole stone without the lower fragment falling off. In like manner, in lifting both bricks the lower brick did not fall off. The slate and the glass seemed also set. So that the experiments seemed to confirm remarkably the view I had formed, on theoretical and chemical grounds chiefly, that saccharine matter added to mortar would be of great value and that an important discovery had been made. I wrote to my brother-in-law, Mr. Guildford Molesworth, engineer-in-chief to the state railways in India, and author of "The Engineer's Pocket Book," telling him what we had done. From him I received a letter dated Simla, August 28th, 1886, giving me the following interesting particulars: "With regard to your addition of sugar to mortar, it is a practice that has been in use in the Madras presidency from time immemorial." The following is an extract from the Roorha (?) "Treatise on Civil Engineering," Vol. I., page 150, third edition: "It is common in this country to mix a small quantity of the coarsest sugar—'goor,' or 'jaghery,' as it is termed in India—with the water used for working up mortar. Where fat limes alone can be procured their bad qualities may in some degree be corrected by it, as its influence is very great in the first solidification of mortar. Captain Smith attributes the fact that mortars made of shell-lime have stood the action of the weather for centuries, to this mixture of jaghery in their composition. He made experiments on bricks joined together by mortar consisting of 1 part of common shell lime to 1½ of sand. One pound of jaghery was mixed with each gallon of water with which the mortar was mixed. The bricks were left for thirteen hours, and after that time the average breaking weight of the joints in twenty trials was 6½ lbs. per square inch. In twenty-one specimens joined with the same mortar, but without jaghery, the breaking weight was 4½ lbs. per square inch."

Mr. Molesworth then adds: "The use of sugar or jaghery was known to me when I was in Ceylon twenty years ago. The masons who came over from Madras used to make most beautiful plaster work, almost like enameled tiles, of shell lime mixed with jaghery. The surface took a fine polish, and was as hard as marble; but it required a good deal of patient manipulation, well suited to the national character."

This intelligence from India supplies proof of the most positive kind of the enormous strengthening power of sugar when mixed with mortar. It may be argued that some of our limes and cements are of themselves good enough without it. It is for engineers to judge whether they might not be made much better by it, or whether the facts I have brought forward do not show plainly that there should be an inquiry instituted by scientific men to investigate the actual *numerical* value of sugar, and the various conditions under which it acts, whether for better or worse. For the worse it cannot act, except such an insane use of it be made by adding too much, as to expect sugar to be itself mortar. The jaghery sugar used in India is sold in the London market at, I think, less than a penny a lb., and is used for feeding cattle. Treacle seems to me to be a most promising form of saccharine matter. I would shirk beet-root sugar. There is a rough unrefined treacle which is very cheap, and I should suppose would be excellent. A halfpenny-worth of treacle and water added to a hod of mortar would, I conjecture, increase its strength by one-third, if not by one-half. But I must leave the matter in the hands of scientific engineers. I think it is very probable that this use of sugar with lime is of extreme antiquity, and that a knowledge of it passed from India to Egypt and Rome; and that these nations used malt for its saccharine matter as a substitute for sugar. I have shown that the mediæval builders used beer in building our cathedrals, and beer is still used with plaster-of-paris. These I take to be the remnants of ancient tradition. It is said that in the cold winter when Bess of Hardwicke died, her masons had to "melt the beer which they mixed with their mortar." They would have acted more wisely if they had used infusion of malt only, for most of the sugar must have been converted into alcohol, and lost for the purposes of mortar making. Antiquarians may be able, from old documents, to throw light upon this subject; but I strongly suspect that the old Roman mortar had saccharine matter added to it; and I am of opinion that, in all engineering works requiring great strength, it would be wrong not to take advantage of facts confirmed by the experience of ages.

CRANLEY, SURREY, November 30th, 1886.

The Technical Education of the Shipwright and Shipowner.

AT the present time this subject should have an especial interest to Americans, from the fact that there is a general public opinion that we ought (speaking in a Hibernian way) to make an effort to regain some of the ground which we have lost on the sea, and it is the evident purpose of the people, and of the government, to make a very material increase in the navy of the country. The following abstract, taken from the London *Times*, of a lecture by Sir E. J. Reed, M. P., will be read with interest and perhaps profit by people to whom it does not

seem to occur that any great amount of special training is needed to build ships or to create a navy.

"Sir E. J. Reed said he would not be guilty of any exaggeration in saying that the technical education of the shipwright and the value of technical education to the shipowner in any broad sense of the words were matters not only of this century but almost of this generation. Nor was this so surprising when it was remembered that whereas the material of which ships were built, the manner in which their parts were combined, and the means by which they were propelled had remained unchanged from the beginning of human experience down to almost our own day, the ship had recently been transformed in every one of these important particulars. The steamship of the present day gave rise to many technical necessities. She was built mainly of steel both in hull and in machinery, and trustworthy steel could only be produced by a large and free application of technical knowledge. The plates of which her hull was constructed were the result of several refined and careful operations. Only by the most thoughtful, patient, and persistent technical study, both theoretical and practical, had the steel plate been produced. Every steel manufactory had become a technical school of chemistry, metallurgy, and mechanics, and the more the shipwright knew about his steel plates the better would it be for him. In his own department, however, he would find abundant opportunity and necessity for technical skill in dealing with his plates. It had, for instance, recently been shown that steel plates of perfect quality were liable to undergo great deterioration in the shipyard or the boiler shop if subjected to pressure and change of form at improper temperatures. It was one thing to procure good steel ship plates and to work them properly; it was another to combine them in the most efficient manner into a structure. The plates had to be bound together with rivets, and the placing of these rivets was a matter of very great importance to the shipowner, for their improper disposition had ruined many a good ship, and it needed much technical skill so to dispose them under all circumstances as to weaken the hull as little as possible. The design and construction of the marine steam engine also made heavy demands upon technical skill with a view of economizing not so much steam and fuel as weight. The naval architecture of the past—that which flourished in the construction of wood ships down even to our own day—although in many respects admirable and beautiful, was, if judged by its results, a poor affair. He had on more than one occasion bore testimony to the great skill of those who produced our splendid wooden line-of-battle ships. But when the steam engine and the screw propeller came in either the material or the technical skill failed us. It may be said that wooden, steam line-of-battle ships did good service in their day, although their day was but a very brief one. But the royal harbors bore abundant witness in the days of his youth to the weakness of the screw steamship built of wood. He well remembered, when a shipwright's apprentice in Sheerness dockyard, taking note of many a steam line-of-battle ship lying at her moorings in the Medway, with her back bent, and, some cases broken, on account of her steam machinery; not on account of the force exerted by her machinery when under steam and at sea, for many of them had never been to sea at all, but on account of the mere weight of her screw propeller and stern shafting overcoming her longitudinal strength. We trusted to the wooden steamship a little too long, and were too reluctant to see her yield to the thrust of the oncoming hull of iron and of steel. The technical knowledge requisite to guide the shipwright in building his iron or steel plates into a structure such as a modern fast steel liner, a tenth of a mile long, capable of being driven across stormy oceans at a speed of a third of a knot per minute, or of 33 ft. per second, without breaking or even straining unduly, had been brought into being gradually and for the purpose. The adaptation of the strength of a long and large steamship to the very great and very variable strains that she would be subject to at sea was indeed a problem upon which much earnest work had yet to be done as the development of shipbuilding advanced. But enough had been done to lay upon the shipwright heavy obligations as to technical study. This was not a matter in which success could be secured by mere brute effort or heedless expenditure. A ship was a construction in which its very strength might become its weakness. It was quite easy—it had often been done by incompetent persons—to lavish material in such places and in such a manner as to weaken the structure in one place by overburdening it at another. Many persons failed sufficiently to realize the nature of the forces which a big ship at sea had to encounter, and failed to fully understand that the movements of such a body, weighing many thousands of tons, transcended all other human experiences of motion and ranked in magnitude with the great catastrophes and cataclysms of nature. Where else on earth save in the case of ships did one find man imparting swift motion to vast masses of matter, wielding and guiding at his will bodies as big as small mountains and propelled by forces that vied with those of earthquakes. In these days the shipbuilder was nothing if not technically trained and instructed, and this necessity for technical knowledge and training descended into the minute details of a shipwright's work. His view of the necessity for technical knowledge went the full length of desiring to see technical instruction extended not merely to the masters and professors of the craft, but to all who were engaged or to be engaged in the production or working of ships. (Hear, hear!) There were people who would be quite ready to promote technical education, in order to serve the purpose in view, in two ways. First, they would like to see the shipbuilders and their sons and their principal officers thoroughly well trained for their work, and secondly, they would like to see provided enough of technical education for the working classes and apprentices engaged in shipbuilding to enable clever young men here and there to rise into higher positions and make their way in their trade or profession. But these objects, though laudable in themselves, fell very far short of what he considered the necessities of the case. He wanted to see educated not only those who had risen or might rise above the hard-working class, but that class itself. (Hear, hear!) This was a competitive age. In such an age we must conceive continually new and improved things, or else we fell astern in the race. In other countries technical education was freely imparted to the people, and they consequently drew their improvements and their mechanical progress from the largest area of cultivated talent. The establishment of the Admiralty Technical Schools of Naval Architecture had been very beneficial in this country, and great good would be obtained if its work was extended more widely and if there was a general diffusion of technical training throughout

the great seaports of the country. The time had come when elementary education was imparted to all children; was it too much to hope that before long all those young men who were destined to become shipwrights or marine engineers would be supplied with opportunities for learning how to apply that elementary education to trade uses? The young men themselves, and society at large, would be the better in many ways for such instruction. The education of young men in matters concerning their daily avocations, and the laws of nature with which they came most into contact, gave to their lives an active interest, for want of which so many sank into idleness and evil."

THE WESTINGHOUSE ELECTRIC LIGHTING SYSTEM.

(From *The Electrician and Electrical Engineer*.)

MUCH interest has been excited in electrical circles by the editorial announcement made in our last issue respecting the success of experiments recently made with the system of electrical distribution by induction, which is about to be introduced by the Westinghouse Electric Company, of Pittsburgh. This interest has been heightened by statements which have appeared in the public press purporting to set forth some of the results which have been attained Having been permitted to examine the apparatus in actual operation, we purpose at an early day to present our readers with a detailed description of the plant; meanwhile a brief statement of the facts, which may be relied upon as accurate, so far as it goes, will doubtless be of interest. The test which we witnessed was made in Pittsburgh. The dynamo was located in the factory of the Westinghouse Electric Company on Duquesne Way and Garrison Alley, Pittsburgh, and the lamps were situated at a distance of three miles from the generator in a suburb of the city, best known as Lawrenceville. The conductor used was No. 4 B. W. G. copper wire, six miles in length out and back, and having a resistance of 6 ohms. The generator is of the alternate class, and was originally designed by William Stanley, Jr., some of the details of the present model having been worked out by Messrs. Westinghouse, Shallenberger, Byllesby, Schmid and others. It is a remarkably well designed, efficient and handsome machine. The body of the armature is cylindrical, 23 inches in diameter and 12 inches face, and is formed of discs of iron magnetically separated from each other, the conducting wire being wound in flat coils upon its face. The field magnets, 16 in number, are arranged in a circle, with their poles facing inward toward the armature and in close proximity thereto. The dynamo is driven at the rate of 1,080 revolutions per minute, thus giving 17,260 alternations of the current per minute or 288 per second. The weight of the entire machine is about 7,000 pounds, and the total weight of copper wire on the armature and field magnet about 800 pounds. The potential at the terminals of the dynamo when running is maintained at about 1,100 volts. An independent exciter is employed for the field, consisting of a small Stanley direct current dynamo of 150 volts and 10 amperes, driven at 1,800 revolutions per minute. The alternate dynamo and exciter are both belted to the shaft of an 18 by 16 Westinghouse automatic engine, rated at 200 h. p., and making 276 revolutions. The potential at the terminals of the main conductors, 3 miles from the dynamo, is 1,000 volts., showing a drop of only 10 per cent. The inductoriums, or "converters," as they are technically called, are placed at the point of consumption, and have their primary wires attached to the main conductors and their secondary wires to the leads which extend through the premises to be lighted and to which the lamps are attached in the usual manner. In the present installation each converter contains 112 pounds of iron and 43 pounds of copper, and is capable of supplying 50 16-candle incandescent lamps at a potential of 100 volts. In one long continued test 850 lamps and in another 1,000 lamps were lighted to their full candle-power on this circuit, and the high commercial efficiency of the system as a whole may be estimated by the result which was obtained of a little in excess of 8 lamps per indicated horse-power.

It will be seen from these data that not more than 1 pound of copper per mile is required for each lamp in this system. It is easy to estimate the immense saving in the cost of installation of an electric light plant which is capable of being realized by the use of this invention. The system of the Westinghouse Company as now perfected is based upon the fundamental patents of Messrs. Gaulard and Gibbs, whose apparatus has for some time been in successful use, though only to a limited extent, in England. Many modifications and improvements have been added to the original system by Mr. Westinghouse himself and by Messrs. Stanley, Shallenberger and other electricians of the company. The remarkable results which we have above chronicled are in fact the outcome of more than a year of elaborate and costly experimentation by a number of the ablest electricians in the United States.

Irrigation in Queensland.

CLIMATIC influences in Queensland, which is a British colony in the northeastern part of Australia, it is said in *Engineering*, appear to run in cycles, long periods of extreme wet succeeding to seasons of unwonted dryness, so that a good system of irrigation would be a great advantage, and it has lately been occupying the attention of the colonists.

The means of irrigation already adopted are various. Windmills of the modern American type are often used for watering stock, and for other farm as well as gardening purposes. They are generally erected over wells, as water appears to be got in almost any parts if the sinking be of sufficient depth. Californian and chain pumps are used by the Chinese, who are largely employed in raising market garden produce in the neighborhood of large towns. The pulsometer pump is also used to a great extent with the colonial gardeners, its simplicity of action, no doubt, appealing strongly to those unskilled in mechanics in a country where engineering establishments are rare, and metal workers of all kinds get very high wages. But in situations where large volumes of water have to be raised, the centrifugal pump naturally commands the situation, and upon some of the large sugar plantations of the north, very important installations of centrifugal steam pumping-engines have been erected. In the Burdekin district, twelve such irrigating plants are now at work.

New Inventions.

December 14, 1886.

During the month of November, 1886, the Patent Office of the United States passed to issue letters patent numbered, in series, from 351,730 to 353,653, both inclusive; of which 377 bear date as of the second; 400 as of the ninth; 398 as of the sixteenth; 374 as of the twenty-third, and 375 as of the thirtieth of said month.

The whole number issued was 1,923; one, under date of November 23d, having been withdrawn.

One hundred and forty-one patents, or 7⅓ *per cent.* of the entire issue, are for devices designed for application to "railway purposes."

Twenty-one for use on horse and cable roads, respectively; two are specifically for use on "elevated" roads; and one hundred and nineteen are for railroads operated by steam locomotives generally.

The devices designed for improvement of current practice on horse-railroads are: Brake, 1; brake-rod handle, 1; car coupler, 1; car draw-hook, 1; car heater, 1; car starters, 4.=9.

For cable-roads: Concrete mold, for forming cable subway, 1; cable, 1; cable grips, 6; curve pulley, 1; and cable-railway plants, 2.=11.

For railroads operated by steam locomotives generally:

Air compressor attachment for locomotive	1
Axle	2
Axle-box dust-guard	1
Axle box	5
Axle bearing	1
Brake-gear, adjustable for regulating travel of beam	1
Brake, pneumatic train brakes	4
Brake pawl	1
Brake operated by fluid pressure	1
Bag-catcher, mail	1
Cars—	
Dumping car	1
Express car	1
Stock car	1=3
Car couplings	31
Car-coupling link	1
Car door, freight	1
Car heater	1
Car-heating and lighting, combined	1
Car lamp	1
Car seat	2
Car spring	1
Car truck	4
Car-wheel chill	1
Car-wheels and axle-handling apparatus	1
Coupler for brake-hose	1
Exhaust quieter	1
Exhaust relief	1

Electric lighting of trains	2
Electric locomotive	1
Frog and switch	2
Frog	2
Gate for street crossings	3
Gate fastener	1
Guard for street crossings	1
Journal	1
Locomotive	3
Locomotive boiler	3
Locomotive furnace	1
Oiler	1
Piston, balanced	1
Rail, for inside of curve	1
Rail braces, manufacture of	1
Seal lock	1
Snow-plow	1
Signals—	
Train signals	1
Road signals	6
Spark arresters	3
Spike	1
Switch	3
Switch, without frog	1
Tie, of metal	3
Turn-table	1
Traction increaser	1
Valve	1
Valve-gear	1
Valve-seat dresser	1
Velocipede	1

Among the 31 "couplers" (and the same is true of any lot of like number heretofore patented) there are several affording evidence of great, if not entire, ignorance, on the part of the inventors respectively, of the conditions under which a car-coupling is necessarily operated. Some of the November lot in question are of particularly fantastic form.

One of the group, however (No. 351,964), shows very simple, and presumably effective, devices for reception, detention and release of link, and for holding the link horizontally in position to engage opposing draw-gear. It would couple *automatically* with any link-carrying draw-gear, as well as with one of its own pattern; provided the link, coming to be engaged with No. 351,964, be presented so that it may hit the orifice of the "throat" of the draw-head of said coupler. It would receive, and secure, any *hand*-guided link without any handling of a *pin* on the part of the person making the coupling.

Of devices other than couplers, there are several noticeably ridiculous. As for instance: One shows a railroad rail having an undulating surface, with six or seven considerable "waves" in a length of 30 feet. In another, instead of a car-wheel of the conventional form, there is a circular plate, rotating on a fixed axle, bearing on its edge small wheels, set "roller-skate" fashion; which small wheels are to "take their places in quick succession" upon the rail. This contrivance would, presumably, prove "a rattler," indeed.

In improvements in locomotive fire-boxes and boilers, we find, under No. 352,215, devices for securing, in a chamber adjacent to the flues of the boiler, a thorough combustion of the gases produced in the fire-box; and in No. 352,217 a fire-box of two compartments, one devoted to the production of gas (from coal used for fuel); and the other—adjacent to the rear flue sheet of the boiler—used as a combustion chamber, into which the aforesaid gas, mixed with air, charged into it by means of a flue provided for that purpose, is introduced at will.

We note also a turn-table, designed to be operated by the weight of any burden (ordinarily a locomotive) placed upon it; such weight being made effective through certain springs and a spiral inclined plane.

In car-seats, No. 352,055 has several good features.

In our review of the November patents we have, perhaps, overlooked some device the "introduction" of which will "revolutionize" railway practice in the line in which such device is intended to serve; but, with our present view of the matter, we have to say, further, only that the month's illustration of the work of our inventors of railway appliances indicates an unflagging industry; and, on the whole, a promising advance in appreciation of the subjects handled. J. M. G.

System of Electric Distribution,*

Specification forming part of Letters Patent, No. 351,589, dated October 26th, 1886, to Lucien Gaulard and John D. Gibbs, of the County of Middlesex, England, Assignors to George Westinghouse, Jr., of Pittsburgh, Pa.

Application filed March 6th, 1886. Serial No. 194,229. (No model.)

To all whom it may concern:

Be it Known, That we, Lucien Gaulard, a citizen of the republic of France, and John Dixon Gibbs, a subject of the Queen of Great Britain, both of the county of Middlesex, England, have jointly invented certain new and useful Improvements in Methods and Apparatus for the Distribution and Conversion of Electric Energy, of which the following is a specification:

Our invention relates to the distribution of electrical energy for industrial purposes, and it consists in an improved art or method, and an organization of apparatus whereby the same is carried into effect, by means of which we are enabled to transmit from a central or supply station through a main conductor a primary electric current of comparatively small quantity but of high potential, and at a point or points more or less distant where the said electric energy is to be utilized, to transfer the energy residing in such primary current of high potential, into one or more secondary currents of lower potential but of greater quantity. To this end the invention comprises certain combinations of apparatus having an organization and mode of operation particularly adapted to effect such transference of electric energy.

By means of our improved method and apparatus we are enabled to convey a useful quantity of electric energy to a much greater distance than has heretofore been practicable, while the cost of the necessary plant for electric lighting and other analogous purposes, especially that of the main electrical conductors, is very materially diminished.

The accompanying drawings represent an organization of apparatus which we have found to be well adapted for carrying out our invention.

Fig. 1 is a theoretical plan showing the general principle of the apparatus; Fig. 2 is a transverse vertical section of one form of converter, and Fig. 3 is a diagram showing one plan of arranging the apparatus when the transference of energy is to be effected at more than one point.

In the drawing, D represents a dynamo-electric generator of suitable construction, organized for the production in the main line of alternating currents, that is to say, successive electric currents or pulsations, alternately of positive and negative polarity and of equal potential and duration. We have found by experiment that the

* We are indebted to *The Electrician and Electrical Engineer* for the engravings accompanying the specification.

dynamo-electric machine of Alteneck, described in United States Letters Patent No. 234,353, of November 9th, 1880, is well adapted for our purpose; but we do not desire to confine ourselves to any particular constructiono f generators for setting up alternating currents in the line, as there are many forms of these known and used which will serve sufficiently well.

In order to operate a dynamo-electric machine for the production of alternate currents, it is necessary to provide some means for maintaining its magnetic field. This may be accomplished by a separate current derived from an independent dynamo machine, technically termed the "exciter." Such independent exciter is shown in the drawing at E. It may be an ordinary direct-current dynamo machine, of any suitable construction. The current of the exciter E is conducted from its terminals p, p, by means of wires 1 and 2, to and through the field-magnet helices of the main dynamo or generator D.

coil has heretofore usually been employed to transfer electric energy from currents of low potential and great quantity into currents of high potential and small quantity, the function of the secondary generator or converter as applied in our invention is precisely the reverse of this, namely, to transfer electric energy from currents of high potential to currents of low potential and increased quantity. We have constructed converters for effecting this result in a variety of forms, all of which involve the same principle. In order that this principle may be better understood, we will describe the construction and mode of operation of a simple form of the converter which we have shown at C in figure 1. Two iron cores b, b^1, are preferably built up from a large number of small soft iron wires, insulated from each other and mechanically secured together in a solid bundle. It is usually preferable to unite the ends of the cores so that they will become magnetically continuous. In figure 3 for example, we have shown

Fig. 1.

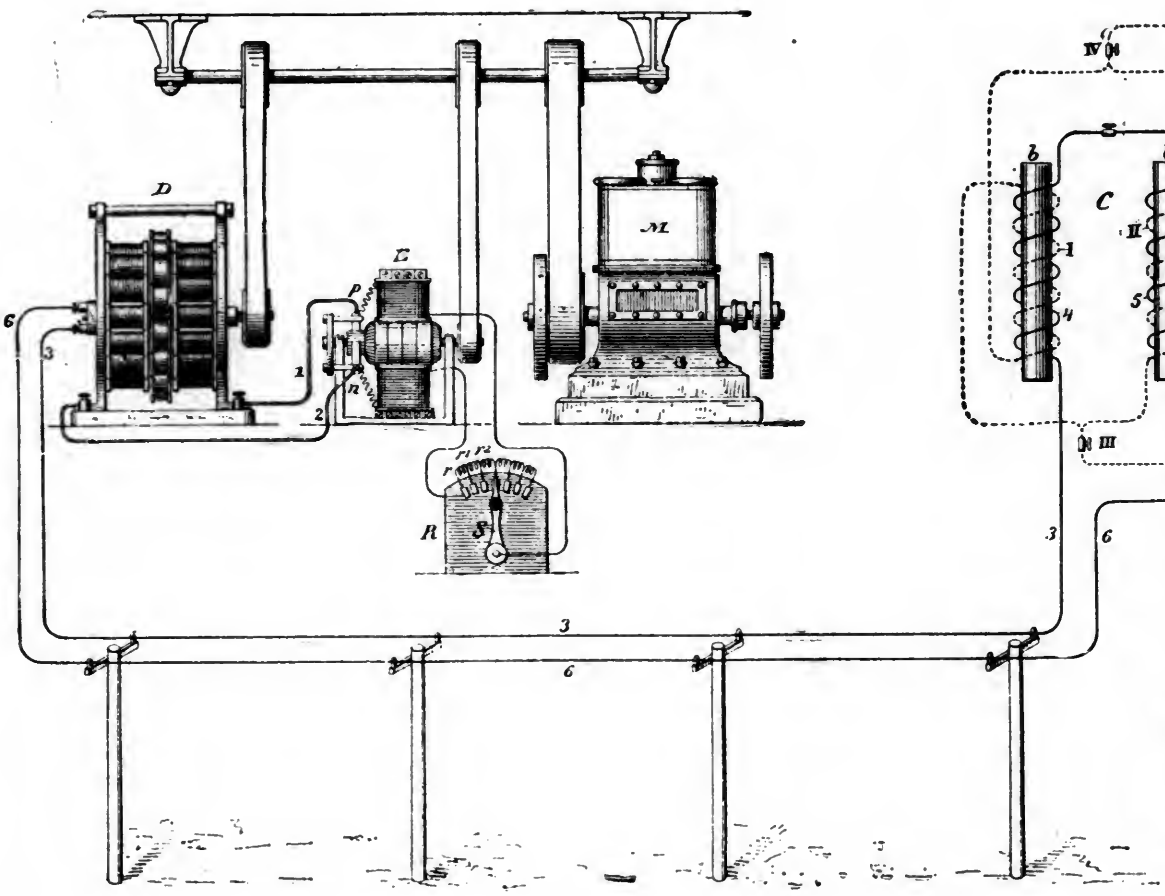
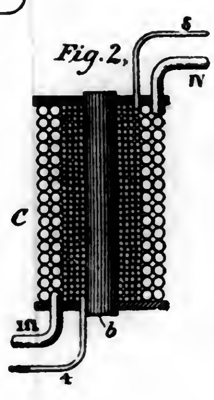


Fig. 2.



In order to vary when required the electromotive force of the generator D, it is convenient to effect a corresponding variation in the strength of the current in the field produced by the exciter E. This may be done in the case of a shunt-wound exciter, by an adjustable resistance inserted in the field of the exciter. We have shown this plan in the drawings. R is a rheostat composed of a series of graduated resistance coils r, r^1, r^2, etc. A movable contact-arm or other equivalent device is provided, by means of which the current for maintaining the field produced by the exciter E may conveniently be regulated. The same result may be reached in other well-known ways. The power for operating the main dynamo D, as well as the exciter E, is furnished by a suitable steam engine or other convenient motor M.

At a point where the electric current is to be utilized for any suitable purpose, as for instance, in one or more incandescent electric lamps, we place one or more secondary generators of converters, as shown at C in figure 1. The general principle of our secondary generatoɪ is analagous to that of the well-known inductorium or induction coil, with this exception, that while the induction

the cores in the form of a rectangle; but the core or cores may be straight cylinders, or closed figures of oval, annular, horseshoe, or other shape, this being merely a matter of convenience in construction or economy in operation, but involving no change of principle. Around the cores b, b^1, the primary electric conductors 4 and 5 are disposed helically in the manner shown in the drawing, which, however, is intended to represent the arrangement of these conductors in a symbolical or typical manner only, the actual construction being preferably similar to that shown in figure 2, hereinafter to be described. By inspection of the drawing it will be seen that one conductor, 4, is coiled upon the left-hand portion of the core, and the other similar conductor, 5, upon the right-hand portion, and the two conductors 4 and 5 are then connected at their adjacent ends, that a current may traverse them in series and thus develop magnetism in the iron cores b, b^1, so as to establish a magnetic field surrounding or enveloping said cores and adjacent thereto. The secondary conductors I. and II. are disposed in precisely the same manner around the cores b, b^1, and within the same magnetic field. In the particular arrangement

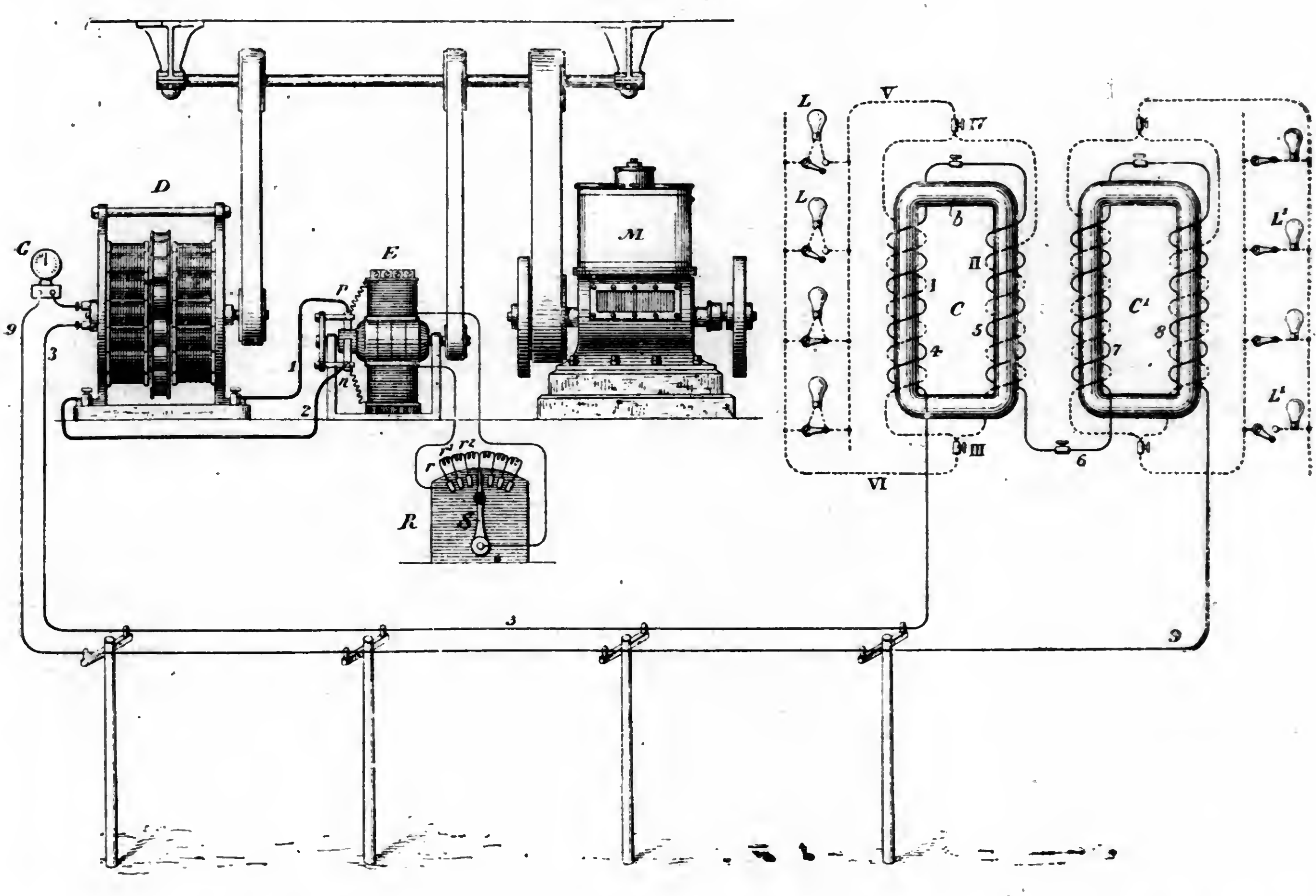
shown in figures 1 and 3 of the drawing, each convolution of the secondary conductor is interposed between two adjacent convolutions of the primary conductor, so that the number of convolutions as well as their mean distance from the axis of the core is the same. Experience indicates that the more nearly the last mentioned relation is preserved, the higher will be the efficiency of the apparatus. The relative disposition of the primary and secondary helices may otherwise be greatly varied without material change in the result; for example, one may be superposed upon the other as in figure 2, or the two may be placed upon different parts of the same core or cores, according to circumstances. It is to be observed that the secondary conductors shown in figure 1 of the drawings are not united in series like the primary conductors, but their ends are joined together as shown at III. and IV., in parallel or multiple arc, and from the last named junction points of the secondary, the conductors

mary currents ordinarily are, by including proper translating devices in said secondary circuit.

The most important and characteristic feature of our invention is that which renders it possible to make use of alternating and equal positive and negative currents of moderate quantity but of very high potential, in the primary or main line circuit, and to convert these into secondary or induced currents of much greater quantity but of corresponding lower potential at the place of consumption, which secondary currents are employed to do the required work. This is a result, the attainment of which is of the utmost importance in the art of electrical distribution, as it renders practicable the employment of insulated main conductors, of comparatively small size and moderate cost, for the transmission of large amounts of energy to great distances.

We will now explain the means by which this increase of quantity and reduction of potential in the secondary

Fig. 3.



V. and VI. are led to an electric lamp or other translating device L by which the circuit is completed.

We will now describe the mode of operation of the apparatus. When the dynamo-electric generator D is set in operation, a rapid succession of alternating positive and negative currents or pulsations of equal potential and duration, technically termed an alternating current, is set up in the main or primary conductor, the path of which may be traced in figure 1 as follows: From one terminal of the generator D by the line conductor 3 to the primary conductor 4, 5 of the secondary generator C, thence returning by the line conductor 6 to the opposite terminal of the generator. The alternate current proceeding from the primary generator D, by its inductive action in the secondary generator C, creates a magnetic field of alternate polarity, and this alternation of the magnetism of the field, in accordance with a well-known law, generates by inductive reaction an alternate current in the closed circuit of a secondary conductor situated within it. The secondary current may be utilized for electric lighting or other purposes in the same manner that pri-

circuit is effected. Let it be assumed that we have an electric lamp, as L in figure 1, so constructed as to work at maximum efficiency when rendered luminous by an electric current of 1 ampere. Let it also be assumed that, for economical or other reasons, it is desired to employ an alternate current of 0.5 ampere only in the primary circuit. The necessary increase in the quantity of the secondary current will, in such case, be effected by the apparatus when arranged precisely as shown in the figure, for as the primary conductor of the converter C is connected in series, while the secondary conductor (with an equal number of convolutions situated in the same magnetic field) is arranged with one-half its convolutions in multiple arc with the other half, the result will be precisely the same as if the actual number of convolutions of the secondary conductor were only half as many as those of the primary. The total resistance of the secondary conductor when thus connected, is obviously only one-fourth as great as that of the primary, the secondary being double the cross-section, and virtually only one-half the length of the primary.

When an electric current of alternating polarity is caused to pass through the primary conductor of the converter C—figure 1—it creates by electro-magnetic induction a magnetic field, the intensity of which, within the ordinary limits of working, is proportional to the current (expressed in amperes) passing through the conductor. Each alternation so produced in the magnetism of the field tends to set up a definite electromotive force in each separate convolution of any conductor traversing the field. In the primary conductor this electromotive force opposes itself temporarily to the primary or magnetizing current, but as it is of inferior and rapidly decreasing potential, it acts merely to delay, and not to prevent, the magnetization of the field. An approximately equal electromotive force is at the same time set up in each convolution of the secondary conductor, but, as the latter (in the present example) makes only half the number of convolutions within the field, the total electromotive force of the secondary current will be only one-half that of the primary current. Inasmuch, however, as the value of any current is expressed by the quotient of the electromotive force divided by the resistance, and as the resistance of the secondary coil is only one-fourth that of the primary, the actual number of amperes in the secondary current will be approximately twice as many as in the primary current. Strictly speaking, however, the inductive action may be said to be determined, not by the number of convolutions but by the extent of conductor, measured in linear units, which is in inductive relation to the magnetic field, assuming the lines of force in such field to be uniformly distributed. In order to produce a proper result, it is preferable that the resistance offered by that portion of the linear conductor in the magnetic field which is traversed by the primary current, shall exceed the resistance of the conductor in the same field traversed by the secondary current, in an inverse ratio to the increase in current strength or reduction of potential which it is desired to effect.

Any required number of converters, of the general construction described, may have their primary circuits united with, or included in, the conductors leading from the primary generator. The manner of connecting such converters, whether in series, multiple arc, multiple series, or otherwise, will be understood by those skilled in the art to which our invention relates, without the necessity of further explanation. One arrangement, however, is indicated in figure 3, in which a second converter, C′, is placed in circuit, provided with a secondary conductor and an independent group of lamps. The primary current traverses the circuit 3, 4, 5, 6, 7, 8, 9, passing through the primary wires of both converters, and the separate groups of lamps are shown at L and L′. We do not herein claim the connection of the converters in the line, in any other arrangement than we have illustrated in the drawings.

It must not be forgotten, however, that the consumption of energy in the main or primary circuit will, in all cases, bear a certain definite ratio to the work which is being done, or at least to the resistance which is offered at any given time in the secondary circuits of the converters, whether one or many. The attendant at the generator, by means of an electro-dynamometer or other suitable current indicator, G—figure 3—can readily detect any change in the strength of the current due to variations in the consumption, and, by moving the arm S, can correspondingly raise or lower the electromotive force of the generator D, so as to bring the current back to its normal strength.

The converter C may be constructed in various ways. We have attained excellent results by constructing it in the manner more particularly shown and described in prior United States patents, Nos. 297,924 of April 29th, 1884, and 316,354 of April 21st, 1885. Another form which gives excellent results in practice, is shown in figure 2, in which *b* is a core formed of a bundle of iron wires, around which the primary wire 4 is coiled in a helix of the ordinary form. The helix of the secondary wire III., IV., is superposed upon that of the primary, in the manner shown. The sectional area of the secondary wire is here shown as four times that of the primary, while the number of convolutions is only one-fourth as great. We nevertheless do not desire to confine ourselves to any particular construction of the converter, as this is quite immaterial so long as the essential principles which we have hereinbefore set forth are not departed from.

We claim as our invention :

1. The hereinbefore-described art or method of electrical distribution and conversion, which consists in establishing in a closed electric circuit, a current of alternate and equal positive and negative potential, producing by the influence of such current an inductive field of alternate polarity, and thereby inducing in translating devices situated in an independent closed circuit traversing such field, a similar alternating secondary current of greater quantity and less potential than the originating or producing current.

2. In a system of electrical distribution, an inductorium or converter, in which the length of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the length within the same field of the conductor traversed by the secondary current, in combination with a dynamo-electric generator producing alternating electric currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

3. In a system of electrical distribution, an inductorium or converter, in which the resistance of that portion of the conductor traversed by the primary current within the magnetic field created by itself, exceeds the resistance of that portion of the conductor traversed by the secondary current which lies within said field, in combination with a dynamo-electric generator producing alternating currents or pulsations of equal potential and duration, and translating devices actuated by said secondary current.

4. In a system of electrical distribution, a dynamo-electric machine, organized for the production of alternate positive and negative currents, equal to each other in potential and duration, in combination with the primary curcuit of an inductorium or converter organized to induce in its secondary circuit alternating currents of lower potential and greater quantity than those of the primary circuit, and one or more translating devices actuated by said secondary currents.

5. In a system of electrical distribution, the combination of an inductorium or converter, having its primary and secondary circuits constantly closed, a dynamo-electric generator for producing alternating currents of equal potential and duration included in said closed primary circuit, and one or more translating devices included in said closed secondary circuit, substantially as set forth.

[NOTE.—The claims of this patent were refused by the Primary Examiner on the ground of lack of patentable novelty, but were allowed on appeal to the Board of Examiners-in-Chief.]

Vogt's Journal-Box Cover.

MR. AXEL S. VOGT, of Altoona, Pa., has patented a cover for railroad journal-boxes. His invention is described as follows in his specification :

Figure 1 is a central sectional elevation through the axle-box and its lid ; Fig. 2, a side elevation of the same ; Fig. 3, a front view of that part of the hinge which is cast with the axle-box ; Fig. 4, a perspective view of the same on the section $x\ x$ of Fig. 3. Fig. 5 is a back view of the hinge put together ; Figs. 6 and 7, side and front views of the compressing-arm. Fig. 8 is a diagram illustrating the action of the device when in use.

A is the axle-box, having the rim, *a a*, around its open end made flat and level.

B is the hinge lug or section, secured to or cast with the box. The form and construction of this hinge-lug is fully shown in Figs. 3, 4, and 5. It is perforated longitudinally for the reception of the hinge-pin, as shown in Fig. 5, and at *b*, Fig. 4.

In the front of the hinge-lug B^2 is an open slot, b^2, and at the top of the slot, and near the top of the lug, is a recess, b' (see Figs. 3 and 4), forming a bearing for the compressing-arm E, Figs. 6 and 7.

b^3 is a projection on the back of lug B.

C is the lid which closes the opening in the box A. If

desired, it may have a rim of soft metal cast into a recess in its fitting-face which rests upon the rim *a* of the box.

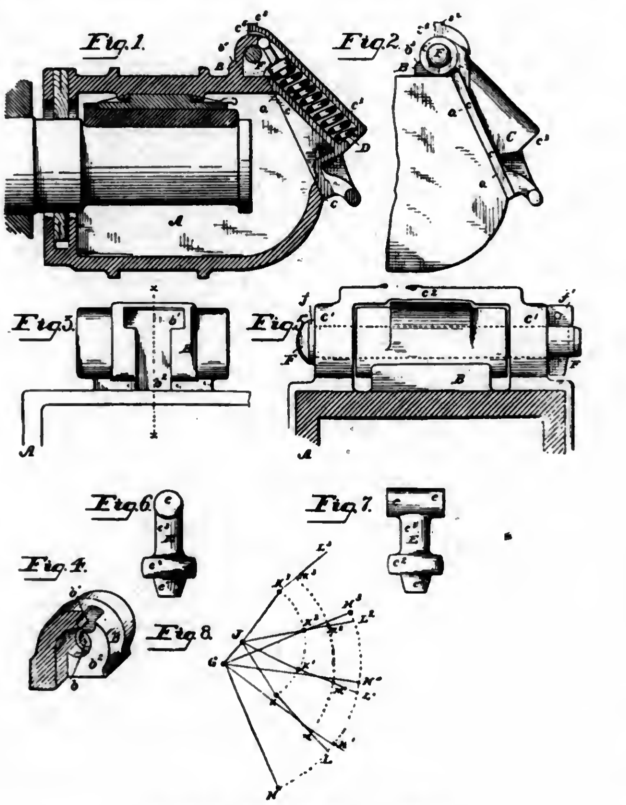
$c' \, c'$, Fig. 5, are lugs perforated for the reception of the hinge-pin, and adapted to register with the lug B.

c^2 is a curved hood which projects over the top of the hinge, covering the recess b', and terminating in a shoulder, c^5, adapted to rest against the shoulder b^3 when the lid is open.

c^3 is a hollow box or pocket cast in the lid C and open at the top.

D is a spiral spring contained in the pocket c^3. The axial line of the pocket must be such as will, when the lid is closed, form a very obtuse angle, such as J K L, Fig. 8, with the compressing-arm E, hereinafter described, which angle will have its apex pointing toward the box.

E is the compressing-arm, having at its top circular projecting arms *e e*, which are adapted to rest in the horizontal recess b', and at its bottom a plug e', adapted to enter the spring D, and a collar, e^2, to rest against the end of the spring. This collar e^2 should be large enough to nearly fill the opening c^3, though capable of moving freely in it. The shaft e^3, of the arm E, is of a size which permits it to move freely in the slot b^2.



VOGT'S JOURNAL-BOX COVER.

F is the hinge-pin ; *f*, an elastic washer.

f' is a key to retain the pin F in place.

To secure the lid to its hinge, the compressing-arm E is first placed in its bearings b' and the spring D is placed in its box c^3. The end e' of the arm E is then inserted in the end of the spring and the lid C then pressed upward into its proper position, when the perforations of the lugs B and c' will be in line and the pin F may then be inserted. The upper or bearing surface of the recess b' should be made to project forward sufficiently to prevent the end *e*, of the compressing-arm E, from slipping out ; but, as an additional protection, the projecting hood c^2, is provided, which will prevent the arm E from slipping out of place, and also serves as a shield to the hinge mechanism.

The operation of the device will be readily understood, and is illustrated in the diagram, Fig. 8.

When the lid C is closed, as shown in Figs. 1 and 2, the face of the lid is in the line G H, Fig. 8, and the axial line of the arm E is represented by the line J K, while the line K L indicates the axial line or line of pressure of the spring D, the points G and J being, respectively, the fixed centers of the hinge and of the bearings upon which the ram E turns. As will be seen, the spring D being under compression, its power is exerted in this position to keep the lid C tightly pressed down upon its seat, and the lid can only be opened by further compressing the spring.

G H′ and G H^2 are two intermediate positions of the lid-face while being opened, the corresponding axial lines of the arm E being shown by the lines J K′ and J K^2, and of the spring D by the lines K′ L′ and K^2 L^2, while G H^3 shows the face of the fully opened lid, the arm E being then indicated by J K^3 and the spring by K^3 L^3. As indicated by this diagram, the angle J K L becomes more obtuse as the lid is forced open until, after becoming a straight line, the apex of the angle reappears in the reverse direction and the force of the spring is then exerted to open the lid C, the shoulders b^3 and c^5 serving as stops to prevent the lid from being too widely opened. The pressure of the spring D is, of course, sustained by the hinge-pin F, which is thus tightly clamped between the lug D and the lugs $c' \, c'$. The elastic washer *f*, by drawing the key f' tightly against the lug c', also aids to prevent the pin being shaken loose by the motion of the car.

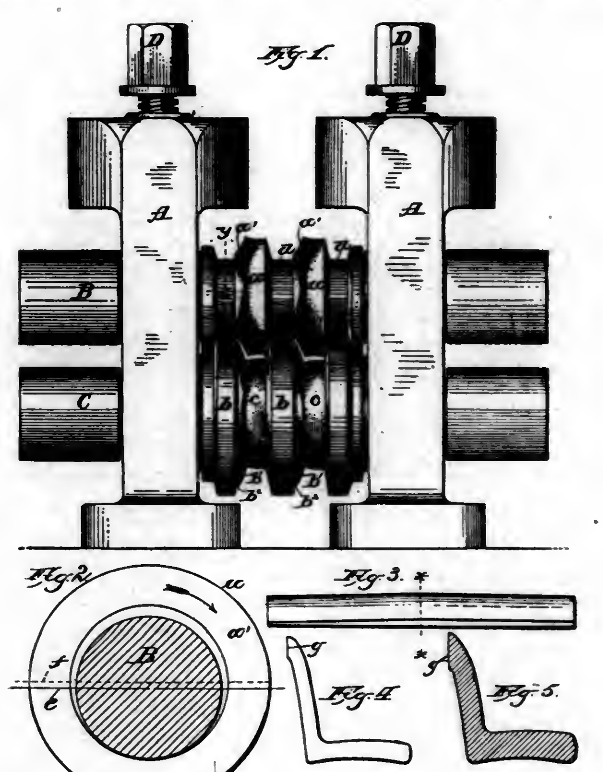
The essential feature of the invention consists of the arrangement of the spring and the compressing-arm with respect to the hinge and lid-face, so that an elastic toggle-joint will be formed to keep the lid closed, and closed and opened substantially in the way indicated.

The patent is dated November 16th, 1886.

Rolling-Mill for Rolling Fish-Plates.

William B. Parkes, of Bay View, Wis., has patented improvements in rolling-mills. The following is from his specification :

My invention relates to rolling-mills, and is designed for rolling angle-irons—such as railway fish-plates ; and it consists in the peculiar construction and arrangement of a train of rolls whereby, at one revolution a reduction is had at both ends of the irons, to leave the greatest thickness at the center, or that portion on which comes



ROLLING-MILL FOR ROLLING FISH-PLATES.

the most strain, as will be hereinafter described with reference to the accompanying drawings.

Referring by letter to the drawings, A A represent suitable standards having journaled therein, after the usual manner, a pair of rolls, B C, the top one, B, being held down in operative relation to the lower one by means

of set-screws D. The top roll, B, is provided with one or a series of tongues, *a*, and the lower one, C, with collars *b*. The tongues *a* of the top roll are in line vertically with the grooves *c*, between the collars *b* of the lower roll, and these collars are likewise arranged with relation to recesses *d*, between said parts *a* of the top roll.

The irons are rolled between the tongues *a* of the top roll and the grooves *c* of the lower one, the faces of these opposing parts being of such contour as to give said irons the requisite outline after being rolled.

The tongues *a* of the top roll are eccentric to the latter's line of axis, as best illustrated by Fig. 2, the relative centers of both this roll and its tongues being respectively shown by the full line *e* and dotted line *f* in said figure.

The collars *b* on the lower roll all have their center on the line of axis of said roll, and the axial line of both rolls determines the centers from which are struck the circumferences of the intervals between the respective parts *a b* of said rolls.

The irons to be treated by my improved rolls are first formed in the usual manner, and are of equal thickness throughout their entire length. These irons, after being suitably heated, are severally fed to the rolls B C, when the eccentric tongues *a* of the top one are at their greatest throw, and the distance between them and the grooves *c* on the lower one the least. The end of the iron first engaged is reduced by the pressure exerted and the surplus metal forced toward the other end. The pressure gradually diminishes as the throw of the eccentric tongues lessens until a half-revolution is accomplished, when, as the throw of said eccentric begins to increase, this pressure is correspondingly increased until the greatest throw is again attained and the iron passed out from the rolls.

The operation just described leaves each iron thickest in its center and gradually tapered therefrom toward each end, as shown by Fig. 3, while the pressure faces of the rolls give said iron the desired contour, this resu t being accomplished at one revolution of the rolls.

In the manufacture of fish-plates, I provide the eccentric tongues *a* of the roll B with a bevel, *a'*, that is also eccentric and opposes a bevel, *b'*, and a shoulder, b^2, on the collars *b* of the roll C. The blanks for the fish-plates are first given their angular shape by other rolls, but are of equal thickness throughout their length, and, when acted upon by my improved rolls, the bevel *a'* on the eccentric tongues *a*, opposing the beveled and shouldered portions *b'* b^2 of the collars *b*, act upon the upper bearing part, *g*, of said plates, so as to give them the greatest width in the center and a gradual taper therefrom to each end, Fig. 5 showing this bearing part at its center and Fig. 4 at one end.

Fig. 1 shows the eccentric tongues *a* on the roll B when at their least throw, and the space between them and the opposing grooves *c* on the roll B the greatest. In this figure I show the rolls constructed to operate upon two angle-irons at one time; but this construction may be varied so as to accommodate a greater number.

Improvements in Locomotives in France.

BY — RICOUR.

(*Compte-rendu de la Société des Ingénieurs Civils, 1885, p. 684.*)

M. RICOUR refers to a preceding article on the subject in the *Compte-rendu*, for June, 1884, and he now communicates the results of additional experience.

Piston or cylindrical valves wear at the rate of one millimeter for 200,000 kilometers run ($\frac{1}{25}$ inch for 125,000 miles), whilst, with the slide-valve, the same extent of wear takes place after 2,060 miles are run, or about one-sixtieth of the mileage-run.

The wear of the valve-gear is reduced in the same proportion. The effect of the change in reducing the consumption of fuel is proved by the returns made at the Saintes station, which show that, in the year 1882, when all the engines worked with slide-valves, the coal consumed, per 1,000 tons conveyed one mile, was 266 pounds, against 234 pounds in the year 1884, when 30 out of 40 locomotives had been fitted with cylindrical valves—showing an economy of 12 per cent. in fuel.

The brick arch or partition, commonly erected in the fire-boxes of locomotives in England, has been introduced on the State railways of France. The bricks of which the partition is formed, are supported on water tubes, rising from the lower part of the tube-plate to the crown-plate, so disposed that the partition takes the form of the letter V, and tends, by its form, to direct the flame toward the sides of the fire-box. The author has made experiments on the resistance of the atmosphere to railway trains, by means of balances placed to the right and to the left of the cab, or shelter, on the foot-plate, having disks of 1 decimeter (about 4 inches) square, and a needle, showing the resistance, on a spring. The resistance varies as the square of the speed. At a speed of 44 miles per hour the resistance is equal to 10 pounds per square foot. The resisting surface of a locomotive with its tender, in the direction of motion, is about 135 square feet, and the total resistance at the above rate would amount to ($135 \times 10 =$) 1,350 pounds. This resistance could be considerably reduced by the adoption of inclined surfaces, which have already been applied to some engines. M. Ricour estimates that an increase of 13 per cent. of useful work would be effected by their adoption; and he estimates that, if all the stock of the State railways were modified as he has indicated, the cost of traction would be reduced £160 per engine per year; and the total reduction for all the 7,000 locomotives now in France, would amount to upward of one million sterling.

The Efficiency of Electric Motors.

A NUMBER of experiments have been made by Mr. W. M. Morday and Mr. C. Watson, at the factory of the Anglo-American Brush Electric Light Corporation, to find out the best principles on which to construct electric motors, and the reason why the dynamo, as a motor, should have a lower efficiency than when working as a generator. As given in the *Philosophical Magazine*, these principles are: (1) That the magnetic field should be a very strong, and the armature a very weak electro-magnet. (2) In both generators and motors, "lead," distortion, or displacement of the brushes or the magnetic field is wrong, and is to be avoided by attention to the (1) condition. If there be any "lead" in dynamos, it is in the direction of rotation; in motors it is in the opposite direction, as the course of the current through the armature is reversed, but the field is the same. (3) In both generators and motors, absence of sparking at the brushes depends mainly on the (1) condition being complied with. (4) Reversal of rotation. In neither generators nor motors is movement of the brushes necessary. It appeared from these principles of construction, which are applicable to both generators and motors, that the lower efficiency of the dynamo as a motor must be due either to friction at the bearings, air friction, and friction of the brushes against the commutator; to loss of energy in heating the armature and field magnets, and to self-induction; or to loss by the production of eddy currents in the iron. From the nature of these probable causes, consideration shows that the last is the true one; for in a dynamo the rotation of the armature causes eddy currents to be generated in the iron core in the same direction as the conductor proper with which the core is surrounded. Of course, as the armature is always more or less subdivided or laminated in a direction at right angles to the lines of force, any circulation of currents round the core is avoided; but local currents or "eddies" are set up, and taken as a whole, these eddy currents on the outside of the core are in the same direction as the current flowing in the copper conductor. In an electric motor, however, the eddy currents and the currents in the copper conductor are in opposite directions, as although the electromotive force set up in the conductor is in the same direction in a motor as in a dynamo, the current in the former is forced through the armature in a direction contrary to the electromotive force. It will be seen that while in a dynamo the two sets of currents, those in the iron and those in the conductor, tend to oppose and to reduce one another, in a motor they act in such a manner as to mutually assist one another. Thus, with the strength of field, the current in the conductor and the speed the same in both cases, the eddy currents in the iron core of the armature will be greater than in a generator, and the loss from heat more. —*Engineering*.

Notes and News.

Thirty-six Inch Car-Wheels.—The Illinois Central Railroad will in future use 36 inch wheels under its cars and tenders.

Foot-guards in frogs and switches, of a pattern which will prevent men from catching their feet, will be required of all Massachusetts railroads by law after January 1th, 1887.

Cable Road in New York.—The Third Avenue Railroad Company has opened a new cable line in New York City. It is on 125th street, running from the East to the North Rivers.

Proposals have been received by the United States Engineer in charge for the construction of jetties at the mouth of the St. John's River in Florida, but the contract has not yet been awarded.

Messrs. Blackmer & Post, sewer and culvert pipe manufacturers, have purchased 12 acres of ground having a frontage of 2,000 ft., on the St. Louis, Oak Hill & Carondelet Railway, upon which to build a new factory.

Electric Brake.—A train is being fitted up on the Chicago, Burlington & Quincy Railroad, with the Park electric brake. This is to be tested by the committee on automatic brakes appointed by the Master Car-Builders' Association.

General Joint Car Inspector.—The roads centering in Cincinnati have decided to appoint a general joint car inspector, who shall decide all matters in dispute between the inspectors of the different roads as to repairs and liability under the interchange rules.

Consolidation Locomotive.—The first locomotives of this class built in Canada—though not the first in use on Canadian roads—have been turned out of the Canadian Pacific shops at Montreal. Four of these engines have been built, having 19 × 22 inch cylinders and 51-inch driving wheels.

Hudson River Tunnel.—There is some prospect of a resumption of work on the tunnel under the Hudson River between New York and Jersey City. Steam pumps are now clearing the old workings of water. As soon as this is done an inspection will be made to ascertain the condition of the sections already built.

The Fowler Steel Car-Wheel Company, of Chicago, are now building on their seven-acre tract, at the north-east corner of Ninety-fifth street and Stony Island avenue, suitable buildings for the manufacture of the Fowler patent solid steel wheels. It is expected the works will be in operation early next spring.

Torpedo Boats.—It is reported that at Elbing—Schicpau's Yard—in Germany, at the present time, torpedo boats are being constructed for Austria, Italy, Russia, Turkey, China and Japan, and that through the improvements in both boats and engines those already tried have attained a speed of twenty-four knots an hour.

The New York, Danbury & Boston Railroad.—The contract for grading this line has been let to Heman Clark & Co. The road is to run from Danbury, Conn., to a connection with the Suburban Rapid Transit road, north of the Harlem River, and is intended to give the New York & New England an independent line to New York.

City Engineer Artingstall, of Chicago, has prepared plans for a viaduct over the railroad tracks at Western avenue and Kinzie street in that city. The bridge is to be of iron, with stone piers and suitable approaches, and the estimated cost is $193,000, of which the City will pay one-third, the railroad companies being required to pay two-thirds.

Hæmoglobinometer.—Ernst Fleischl Von Marxow, of Vienna, has taken out a patent in this country for a hæmoglobinometer. His invention, he says, "consists in a method of ascertaining the relative or quantitative proportion of hæmoglolin in the blood." It is, perhaps, well to mention this fact, as otherwise his invention might be mistaken for a new kind of apple-parer, clothes-wringer or car coupling.

The Chrome Steel Works, of Brooklyn, N. Y., have concluded to substitute gas for coal in their heating furnaces. It will be necessary to tear out their old furnaces, and put in regenerators in their stead. The new plant will be complete in every respect, even to apparatus, for the manufacture of the necessary gas, which will be made on the premises. This improvement will increase the productive capacity of the works twofold.

The Knowles Steam Pump Works, of New York, have taken a contract to supply the water works of Cleveland, O., with compound condensing duplex pumping engines, to pump 23,000,000 gallons a day against a head of 230 feet, with a boiler pressure not exceeding 70 lbs. The engines are to have high pressure cylinders 37 in., and low pressure 70 in. diameter with 4 ft. stroke; the pump plungers are to be 37 in. diameter. The contract price is $79,000.

United States Engineer Corps.—The following promotions are reported: Captain James F. Gregory, to be Major, vice Gillespie, promoted. First Lieutenant Willard Young, to be Captain, vice Gregory, promoted. Additional: Second Lieutenant Charles S. Riche, to be Second Lieutenant, vice Sanford, promoted. Captain H. M. Adams, and Second Lieutenants W. M. Black and H. M. Chittenden have been ordered to report at New York, Jan. 10., to be examined for promotion.

Ship Building on the Lakes.—Statistics collected by the Cleveland *Plain Dealer* show that thirty-one new boats will be added to the lake fleet next spring, having an average carrying capacity of a little over 2,000 tons each. All except two of them will be large steamers, and they represent a combined carrying capacity of 65,750 gross tons, built at a cost of over $4,000,000. Eleven of the finest of these boats are now under way in Cleveland, and in them Cleveland capitalists will invest $1,500,000.

Westinghouse Building.—Ground has been purchased at the intersection of Penn Ave. and Ninth street, Pittsburgh, for the erection of an edifice to be called the "Westinghouse Building." The structure will cost $200,000 and is to be completed by July 1, 1887. It will be eight stories high and will contain the general offices of the Westinghouse Air Brake Co.; the Westinghouse Machine Co.; the Westinghouse Electric Light Co.; the Union Switch & Signal Co.; the Safety Appliance Co., and the Philadelphia Gas Co.

Port Henry, Essex Co., N. Y.—The Bay State Furnaces, which have been for about 5 years unused, have recently been purchased by Messrs. Witherbees, Sherman & Co., who own large iron-ore mines in town, besides a broad-gauge railroad from here to Mineville, where their mines are situated. About 50 men are putting the works in shape, and the production of pig-iron will be resumed as soon as possible. The furnaces are situated on the track of the D. & H. C. Co.'s R. R. They were built about 40 years ago by a Boston company.

Arsenals and Shipyards for China.—The late director-general of the John Cockerill Company, Baron Sadoine, is proceeding to China, as is said in some quarters by invitation from one of the most influential and powerful persons in the country, to consult about the establishment of very extensive arsenals and shipbuilding yards. This may or may not be. He will, however, find that the French have anticipated him in these two matters; but at any rate, he goes in the interest of Belgian industry, and the masters of works expect great results from his mission.

System of Conveying Natural Gas.—The interference case of W. D. Hartupee against George Westinghouse, Jr., and John Nicholson Jr., in the matter of priority of invention of the double-pipe system of conveying natural gas to consumers has been decided by the Commissioner of Patents and Chief Examiner in favor of Hartupee. It is said that a great deal of money is involved, as a number of companies have been paying royalty to Westinghouse for the use of his system. The decision is that of an examiner in the Patent Office and is not final.

Petroleum Engine.—A *Times* (London) telegram calls the attention of the British Government to a new petroleum engine invented by Herr Siegfried Marcus, of Vienna, and which he is supplying to the German navy for its torpedo boats. The machine is set in motion by electro-magnetism. It has far more power than a steam engine of the same size, is less liable to derangement, and is not subject to explosions. Moreover, the fuel which feeds it takes up much less space than coal. All the experiments made with this engine have been satisfactory.

A Remarkable Accident occurred on the Pittsburgh, Cincinnati & St. Louis road, in Pittsburgh, on the morning of November 18th. As a train was approaching the city, a landslide, starting over 100 ft. above the track, rolled down the steep hillside and struck the rear cars of the train, wrecking two sleeping-cars and injuring nearly everyone in them. The road at this point runs at the foot of the hill and near the river, but it has been built over 30 years and was considered perfectly safe. Heavy rain had softened and loosened the earth near the top of the hill, however, and a slide started, with little or no warning.

The Croton Aquednct.—The contractors on the new Croton Aqueduct for New York City, during the year ending December 1st, completed 14.84 miles of the work. This

makes 20.37 miles now completed, leaving 9.41 miles still to be built. Of the 78,361 feet reported as finished last year, Brown, Howard & Co. built 34,308 feet; O'Brien & Clark, 25,740 feet; Heman Clark, 15,272 feet; and John Brunton & Co., 3,041 feet. The Aqueduct Commission has appointed Messrs. George S. Greene, J. J. R. Croes and James B. Francis a commission to report on the practicability of the proposed dam and storage reservoir at Quaker Bridge.

The Engineers' Club of St. Louis, at its December meeting, listened to and discussed an elaborate paper on the "Economic Co-efficient of the Shunt Dynamo," by Prof. F. E. Nipher. The paper gave a mathematical discussion of the theory of the efficiency of this class of machines, and showed the conditions under which a maximum was reached. The life and resistance of incandescent lamps was also discussed. The club appointed a committee of five to consider the subject of a closer connection of existing engineering societies, with a view to forming a general or federal organization.

Consolidated Petroleum.—The German correspondent of *The Engineer* says: "Trials, which appear to warrant success, have been made here for hardening or consolidating petroleum and naphtha, for the convenience of overland transport. The material—at present kept secret—by which this is accomplished is a well-known commercial article. It is true that it costs two and a-half times as much as the petroleum; but it is not lost by the process, as it is regained. The advantages claimed are that no evaporation takes place, and, consequently, that no explosions can occur, and that there is a great gain in freight; for instance, between Hamburg and Vienna, 70 per cent."

A bridge which recently gave way on the Brattleboro & Whitehall road in Vermont, is to be replaced by a heavier one, built by the Vermont Construction Company, of St. Albans, Vt. The road is narrow-gauge, and the bridge which failed was designed to carry rolling-stock of the lightest kind. As has been the case on some other roads of this kind, however, the weight of the equipment was gradually increased until the cars were made to carry loads nearly as heavy as standard-gauge cars, the result being a serious accident from the failure of the bridge. The company has taken warning, and a second bridge, which is still in use, is also to be replaced by a heavier structure.

Water Rights in New Jersey.—It is a fact not generally known that for some time past there has been quietly going on a process of absorption of the water rights of the mountain lakes and streams of Northern New Jersey. Much of this has been done under a general law of the State, authorizing the formation of water companies, and it has been done, probably, largely with a view to the future profit which is sure to accrue to the owners of the water supply which will, at no distant day, be needed by the many towns and villages of that section of the State. Nearly all of them are growing rapidly, and very few have a supply of water at all suited for their future needs.

An Extraordinary Accident occurred on board the Red Star steamship *Westernland* upon her recent voyage from Antwerp to New York. A double sea rose in front of the vessel, came up over her bows, and down in a solid mass upon the middle of the forward turtledeck, breaking it in and killing six persons—four sailors and two immigrant passengers—and injuring more or less seriously fourteen others, six of them sailors. She sailed from Antwerp on November 20, under command of Capt. Randle, with 69 cabin and 574 steerage passengers. A subscription of 2,000 francs was made by the passengers for the benefit of the families of the men who were killed.

Electric Lights in Collieries.—In the collieries of Wales, the correspondent of *The Engineer* says there has lately been considerable growth of the use of the electric light. It was first tried at the Mardy Colliery, and lately introduced to the stables and main levels of one of the Plymouth company's pits. Now the whole question has been brought in a masterly manner before the notice of the South Wales Institute of Engineers, by Mr. Hann, one of the Powell Duffryn managers. Mr. Hann's theory was to have no naked light in the colliery at all, but to light the miners' lamps by electricity from accumulators in the colliery. The meeting listened favorably to the details of the patent, and it was decided by several coal-owners present to try the plan.

Steamless Road Locomotives.—In order to render invisible the escape steam of tramway and other locomotives, Mr. R. C. Parsons, of Leeds, provides in a boiler of the locomotive type two sets of tubes, the one set of comparatively small diameter, and the other set of larger diameter, each set being capable of being more or less closed at the smoke-box end of the boiler by suitable slides or valves under the control of the driver. When the driver observes that the steam issuing from the chimney is more or less visible, he closes more or less the small tubes and opens more or less the large tubes, thus admitting to the smoke-box a greater amount of heat from the fire, which has the effect of rendering the steam invisible.—*Industrial Review.*

Boston Passenger Stations.—An important engineering work now under consideration in Boston is the consolidation and rearrangement of the passenger stations for the railroads entering the city from the north, the principal objects being to provide increased accommodations and to avoid the numerous crossings now existing, where the roads cross each other at grade. No definite plan has yet been adopted, but it is suggested that a new station for the Boston & Maine and the Eastern roads be built at Haymarket Square, with an entrance by elevated tracks, and that the existing Boston & Lowell station be utilized. There are many conflicting interests, and the work of preparing plans to unite all is not an easy one.

Deflection of Railway Bridges.—A novel method of measuring the deflection of railway bridges has been tried in Russia. An iron pipe 1½ in. in diameter was carried along the outside of one girder. From this pipe, at each abutment, at the pier, and at five intermediate points on each span, vertical pipes of the same diameter branched out. Inside, and near the top of each vertical pipe, was fixed a graduated ¾ in. glass tube, the iron pipe being cut away on both sides. The zero divisions on the tubes were all the same distance above the flange of the girder. Before the bridge was loaded the apparatus was filled with water, the tops of the upright pipes covered over, and the water was then drawn off until it stood at zero in each gauge. On the bridge being loaded the deflection could be read with ease.

Cable Road for Third Avenue.—It has been decided by the directors of the Third avenue horse railroad in New York to lay a cable for the whole of their lines. Those directors who had been somewhat favorably disposed toward electrical motors agreed that these, though desirable, were not yet in shape for practical use and that the cable was the most available system for the present. Even if electricity should be found suitable for use a few years hence, they said the substitution of it for the traction system could be easily accomplished. It was agreed that before deciding upon any particular style of road a committee should make a careful study of the matter, visit Philadelphia, Chicago, San Francisco and all other large cities employing the cable system, and report to the board. Robert W. Tailer, William Remsen and Silvanus S. Riker were appointed on this committee, and they will enter upon their duties at once. To change the line as the company proposes to do will cost about $1,500,000.

The Tay Bridge, according to the report of the North British Railway, is nearly completed. The plans of Mr. Barlow, as engineer, were approved by the directors in March, 1881, the fall of the original bridge having happened on December 28th, 1879. The new bridge provides four spans of 245 feet each, for the navigation of the river, with a clear headway of 62 feet instead of 88 feet as in the old bridge; the bridge is on a uniform gradient of 1 in 180, while the old bridge had gradients as sharp as 1 in 74. North of the navigable spans are now 18 spans, instead of 9 as formerly, with the track above the girders. The piers are concrete and brickwork up to 8½ feet above high water, and above that they are made of riveted wrought-iron; the bridge terminates at each end in brick arches. The contract for the new viaduct was let in 1882; the total expenditure on the new work, including the removal of the wreck and old piers, will not fall short of $5,000,000.

The Lappin Brake Shoe Company has been organized with a capital of $1,000,000, to manufacture the Lappin brake shoe and improved Christie head. Its officers are W. F. Collins, president; Thomas Milburn, treasurer, and W. S. Dehart, secretary. A foundry, 80 x 100 feet, is nearly completed at Bloomfield, N. J., and it is expected to begin to fill orders in a few weeks. The shoe is cast in one piece, but with alternating sections of chilled and soft iron. The soft sections, when cast, project about ¼ inch beyond the hard sections. The soft portions take the first wear, and as they wear down the shoe becomes accurately fitted to the wheel. The chilled sections give the shoe great durability. In the improved Christie head the four bearing points of the head are cast on a stationary chill. This case-hardens the bearings, producing increased durability. It also insures uniformity. The foundry will have a capacity of 25 tons per day, and it is intended to erect other foundries at the larger railway centers throughout the country. The offices of the company are at 239 Broadway, New York.

The Old Colony Railroad Company, in its last annual report, notes the fact that the heaviest expenditures for improvements during the year, have been made with the view of dispensing with highway grade-crossings. At several points the grade of the highways has been changed and bridges built over the track, while at one point a road is to be carried under the track, at a considerable expense. Other Massachusetts roads are doing some work in the same direction, but the Old Colony is, apparently, the first company to fully recognize and accept the fact that, in a thickly settled section like Eastern Massachusetts, grade-crossings are a dangerous nuisance, which cannot be permitted to exist much longer. The Massachusetts Railroad Commissioners have taken this view for several years past, and have, so far as their powers extended, steadily refused to authorize new grade-crossings, and have urged the abolition of existing ones wherever possible.

The Pennsylvania Railroad Company has prepared plans for the elevation of its passenger tracks through Jersey City, with a view to the abolition of the many dangerous street-crossings in that city. From the eastern end of the cutting through Bergen Hill, an iron viaduct, about 25 feet above the street level, will carry the tracks to Henderson street. At this point the grade will begin to descend toward the ferry, and the road will be an earth embankment enclosed in masonry walls, the streets being carried underneath the embankment by arched tunnels. One street is to be closed entirely, provided the necessary authority is obtained. The company is ready to begin work on this improvement as soon as the City Council approves the plans. The only obstacle appears to be some local opposition to the closing of Greene street, but this street is already so blocked by the constant passage of trains and yard engines as to be passable only with much delay and great danger. No plan can be devised for keeping it open which does not require the raising of the passenger station and yards, the expense of which would be so enormous as to make it impracticable.

Water Supply of Newark.—The cities of Newark and Jersey City, N. J., which draw their water supply from the Passaic River, are not at all satisfied with the present condition of affairs. There has been in existence for some time a Joint Board on Water Pollution, appointed by the Water Commissioners of the two cities, and this Board reports increasing trouble with manufacturers and others. The Passaic supply is abundant in quantity, but the existence of the large city of Paterson on the river, only some 10 miles above the point where the Newark and Jersey City supply is taken, and the presence on the river and its tributaries of many manufacturing villages and a dense population, make it a difficult matter to prevent such pollution of the water as shall render it altogether unfit for use. The upper water-shed of the Passaic is a mountain region, which gives a water supply of excellent character; the trouble arises altogether from the large population of the country bordering on the lower portion of the river. Many plans have been proposed for avoiding the present difficulty, but unfortunately no other supply is available for the cities, which does not require the construction of long aqueducts at a great expense.

Inspection of Boilers in the British Navy.—According to the new instructions of the Admiralty, boilers of all ships in commission are to be examined and drill-tested from time to time during the commission, by an engineer officer other than the officer in whose charge they are. The detailed results of the examination, together with a statement showing the previous treatment of the boilers, are to be forwarded to the Admiralty. Copies are also to be furnished to the inspector of machinery on the station and to the chief engineer of the flagship. Unless the examining officer thinks it necessary, not more than one boiler in four need be drilled for thickness, preference being given to those which are deemed to be most worn; but all the boilers are to be examined, and separate detailed reports are to be forwarded for each boiler drilled. Should there be any defects in the boilers, internal or external, or symptoms of corrosion, the report is to state what they are, and the steps that are being taken to make good the defects or arrest corrosion. The boilers are to be drilled during the time the ship is in commission at intervals of not less than eighteen months, nor more than two years, and the first drill test is to be made as soon as convenient after the ship has been eighteen months in commission. When a ship is ordered to be commissioned her boilers are to be drilled either before she is commissioned, or as soon afterwards as may be convenient. The boilers of ships attached to the home ports, where there is a Steam Reserve, will be drill tested by the officers of the Steam Reserve. The boilers of ships of the First Reserve will be drill tested by the dockyard officers, when in hand for the annual refit.

PERSONALS.

Mr. H. R. Holbrook has been appointed Chief Engineer of the projected Pueblo & Eastern road. His office is at Pueblo, Col.

Mr. Eliot C. Clarke, recently Chief Engineer of the Massachusetts Drainage Commission, has been appointed Treasurer of the Booth Cotton Mills, at Lowell, Mass.

Mr. Charles W. Irish, a railroad engineer of long experience, has been appointed by the President, Surveyor General of Nevada.

Prof. Rossiter W. Raymond has been appointed as an expert to examine the lighting and ventilation of the new Croton Aqueduct tunnel.

Mr. George R. Hardy, late of the Boston & Albany, has been appointed Assistant Chief Engineer of the Lake Shore & Michigan Southern road.

Mr. Walter S. Keen is appointed Engineer of the Western Division of the Norfolk & Western road, in place of Mr. H. H. G. Handy, assigned to other duty.

Mr. Thomas B. Russam, late chief draughtsman, is now acting Master Mechanic of the Central Railroad of New Jersey, in place of William Woodcock, deceased.

Mr. Robert Narland Brown, at one time Assistant Engineer, and afterward Division Superintendent of the Erie Railway, died Nov. 16, at Wiesbaden, Germany, aged 70 years.

Col. James Boon, an extensive railroad contractor, and father of Mr. James M. Boon, Superintendent of Motive Power of the West Shore road, died in Lancaster, Pa., Dec. 13, aged 83 years.

Mr. Walter Shepard, has been appointed Assistant Chief Engineer of the Boston & Albany road, to succeed Mr. George R. Hardy, who has gone to the Lake Shore & Michigan Southern.

Mr. E. F. Smith has been appointed Superintendent and Engineer of Canals of the Philadelphia & Reading Railroad Company. There has been a regular change and reassignment among the division engineers of that company.

Mr. John A. Grant, formerly Chief Engineer, and for a time General Superintendent of the Louisville, New Orleans & Texas road, has been appointed General Manager of the Texas & Pacific in place of George Noble, deceased.

Mr. L. B. Davies, now a resident of Columbus, O., claims to have designed and put in use the first locomotive pilot or cow-catcher of the pattern now generally adopted. His first pilot was put on an engine on the Columbus & Xenia road in 1853, Mr. Davies being at that time Master Mechanic of the road.

Mr. J. G. Osborne, formerly Assistant Engineer, and lately Trainmaster of the New River Division of the Norfolk & Western road, has been relieved of his duties and placed in charge of a preliminary survey for an extension of the line to the Ohio River.

Mr. John B. Root, the inventor of the Root sectional boiler and of other mechanical devices, died at his residence in Portchester, N. Y., December 11th, aged 56 years. Mr. Root was an active member of the American Society of Mechanical Engineers.

Mr. Jacob Johann, First Vice-President of the Master Mechanics' Association, and one of its best-known members, leaves the Chicago & Atlantic road to become Superintendent of Motive Power and Rolling Stock of the Texas & Pacific. Mr. Johann's office will be at Marshall, Texas.

Mr. Alfred W. Fiske, who died in Pottsville, Pa., Nov. 30, aged 66 years, was for a number of years Manager of the Fishbach Rolling Mill and the Pioneer Furnace at Pottsville. He was, from 1868 to 1873, General Manager of the Northern Central Railway.

Mr. Gilbert C. Breed, who died in Louisville, Ky., Nov. 17, was for many years a railroad engineer. His first service was in New York, where he was employed in the location and building of the Rochester & Niagara Falls, and other lines. Subsequently he was assistant engineer in the location of what is now the main line of the Wabash, and in 1856, went to Kentucky, where he became Chief Engineer of the Memphis, Clarksville & Louisville road, now part of the Louisville & Nashville. He was also connected for a time with the Nashville & Decatur, and the Nashville, Chattanooga & St. Louis roads. For some ten years past his work has been in the operating department entirely, and some months ago he retired from work altogether.

Manufactures.

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

THIS company has just published a new descriptive catalogue of locomotives built in its shops, which contains an account of the origin and history of this establishment, and of what may be called the mechanical evolution of the locomotive in these works. The first portion of this has been reprinted from advanced sheets in the AMERICAN RAILROAD JOURNAL during the last half of 1886. Owing to the consolidation of that journal with *Van Nostrand's Engineering Magazine*, it has been thought desirable to republish that portion of the history and origin of the Rogers Locomotive & Machine Works, which has already appeared in the AMERICAN RAILROAD JOURNAL, in the consolidated publication, in order that all its readers may have the history complete.

CHAPTER I.

THE Rogers Locomotive and Machine Works were founded by Thomas Rogers, who was born March 16th, 1792, in the town of Groton, in New London County, Connecticut. He died in New York City, April 19th, 1856. He served in the war of 1812, and was a lineal descendant of Thomas Rogers, one of the Pilgrim Fathers who came over to this country from England in the Mayflower. At the age of sixteen he was apprenticed to learn the trade of a house carpenter, and in the summer of 1812 he removed to Paterson, N. J., then a small village, which at that time was very prosperous on account of the demand for American manufactures brought about by the war with Great Britain.

At this time, he was employed as a journeyman carpenter, and was noted for his constant application to business, good judgment, and force of character. A few years afterward, Captain Ward, who had been traveling in Europe, where he had seen the power-loom in operation, came to Paterson for the purpose of introducing the manufacture of cotton duck. Mr. Rogers was employed to make the patterns for these looms. He very soon understood their construction and recognized their value, and bought from Captain Ward the patent-right for making them.

In 1819, he associated himself with John Clark, Jr., under the firm name of Clark & Rogers. They commenced work in the basement story of the Beaver Mill, a building which at an early day had been put up by Mr. Clark's father. Shortly afterwards, Mr. Rogers visited Mexico, where he received large orders for looms, etc. In 1820, the firm moved into the little Beaver Mill, and in the following year took into partnership Abraham Godwin, Jr., and the firm name was then changed to Godwin, Rogers & Co. They then commenced spinning cotton, and building machinery for that and other purposes.

In 1822, finding their accommodations too limited, they leased Collett's Mill and moved into it. Their business continued to increase, the number of persons employed being sometimes as high as 200. The establishment continued to prosper until the summer of 1831. In the latter part of June of that year Mr. Rogers withdrew, and took with him $38,000 as his share of the profits of the firm.

He then took a mill-site on the upper raceway in Paterson, and immediately commenced the erection of the "Jefferson Works," which were finished and put in operation before the close of the following year. The location and building of the "Jefferson Works" was literally an encroachment on the forest. On the upper race no factories had been put up, except two little cotton mills and a small machine shop, the latter owned by Messrs. Paul & Beggs. Between Spruce and Mill streets, all was swamp covered with pines.

It was the intention of Mr. Rogers to devote the lower stories of the "Jefferson Works" to building machinery, and the upper stories to spinning cotton. The latter was, however, never commenced, as the demand for machinery increased so fast that the whole of the new building was devoted to that branch of the business.

In the early part of 1832, he associated with himself Messrs. Morris Ketchum and Jasper Grosvenor, of New York, the name of the firm being Rogers, Ketchum & Grosvenor.

In that year the railroad from Jersey City to Paterson was approaching completion, and the iron work for the bridges over the Passaic and Hackensack rivers had been made by Mr. Rogers. An order was also executed for one hundred sets of wheels and axles for the South Carolina Railroad, of which Mr. Horatio Allen was the chief engineer. A short time before, Mr. Allen had visited England to get information about the use of locomotives on railroads, and at the time he ordered the work for the South Carolina Railroad he recommended Mr. Rogers to undertake the construction of locomotives.

In the following letter, written more than fifty years after the event, Mr. Allen describes his interview with Mr. Rogers:

"SOUTH ORANGE, N. J., December 31st, 1884.

"DEAR SIR:—The earliest railroad work in this country was done by the West Point Foundry Association, to which was entrusted the order for railroad wheels for the South Carolina company, and other work for that company.

"Knowing that the era that had opened would require works specially appropriate to the construction of the rolling-stock up to the locomotives, I obtained authority, in the spring of 1830, from the South Carolina Railroad company, to seek the works which, in position, instrumentalities, and preparedness, were in condition to undertake and were willing to undertake what was wanted.

"The result of inquiries to the end in view led me to call on Rogers, Ketchum & Grosvenor, a firm then engaged in the manufacture of machinery for cotton and woolen mills, whose works were at Paterson, N. J.

"At these works I called, and asked an interview with Mr. Rogers, the partner having charge of all the mechanical operations of the firm. It was without any letter of introduction or any *personal* knowledge of each other. My subject was my introduction, and Mr. Rogers very soon led me to know that I had come to the right place and to the right man.

"At the close of an hour's conversation Mr. Rogers expressed his readiness to enter the new field, and to undertake any orders that were entrusted to the firm. The future of 'The Rogers Locomotive Works' was determined at that hour's conversation.

"The personal and business relations which followed this interview continued for many years, and were to me of the most satisfactory character.

"Yours truly, HORATIO ALLEN."

CHAPTER II.

THE EARLY HISTORY OF RAILROADS IN THIS COUNTRY.

In 1833, railroads were already attracting a great deal of attention in this country. The opening of the Erie Canal for commercial purposes in 1826, and the consequent diversion of traffic from other seaboard cities to New York, led the people of Philadelphia, Baltimore, Boston and Charleston to seek for means by which their lost trade could be recovered. Investigation and accurate surveys soon showed the impracticability of constructing canals from Baltimore to the Ohio river, or from Boston to the Hudson. In the meanwhile, information concerning the successful use of steam-power on the Stockton & Darlington Railroad in England, which was opened in 1825, had reached this country, and the public had received the reports of the celebrated experiments with locomotives which were made on the Liverpool & Manchester Railway in 1829. As Mr. Charles Francis Adams, Jr., has expressed it:*

"America suffered from too few roads; England from too much traffic. Both were restlessly casting about for some form of relief. Accordingly, all through the time during which Stephenson was fighting the battle of the locomotive, America, as if in anticipation of his victory, was building railroads....

"The country, therefore, was not only ripe to accept the results of the Rainhill contest, but it was anticipating them with eager hope."

After the experiments referred to had been made, full reports giving in detail their results were published in this country, committees of inquiry were sent to England to get information and report on the railroads of that country, and a railroad mania began to pervade the land.

The first railroad which was built in the United States was a short line of about three miles, from the Quincy granite quarries to the Neponset river, † for the transportation of granite for the Bunker Hill monument. This was merely a tram road, and was operated by horse-power and stationary engines, and was built in 1826. As Mr. Adams says:

"Properly speaking, however, this was never—or at least, never until the year 1871—a railroad at all. It was nothing but a specimen of what had been almost from time immemorial in common use in England, under the name of 'tramways.'"

A similar work was constructed at about the same time for the transportation of coal from the pit's mouth to the Lehigh Valley Canal near Mauch Chunk, Pa.

In the latter part of 1827, the Delaware & Hudson Canal Company put the Carbondale Railroad under construction. This road extends from the head of the Delaware and Hudson

* See "Railroads: their Origin and Problems."

† It has recently been stated that as early as 1809 an experimental railroad track, 180 feet in length, was laid in Delaware County, Pa., and that in the same year a road about a mile long was constructed from stone quarries on Crum Creek to a "landing" on Ridley Creek in the same county and State. The evidence upon which this statement is based has not been made public.

Canal at Honesdale, Pa., to the coal mines belonging to the Delaware & Hudson Canal Company at Carbondale, a distance of about sixteen miles. This line was opened, probably, in 1829, and was operated partly by stationary engines, and partly by horses. The line is noted chiefly for being the one on which a locomotive was first used in this country. This was the "Stourbridge Lion," which was built in England under the direction of Horatio Allen, then an assistant engineer on this line. It was tried at Honesdale, Pa., in August, 1829.

According to "Poor's Railroad Manual for 1876 and 1877": "It was not until 1828, that the construction of a railroad was undertaken, for the transportation both of freight and passengers, on anything like a comprehensive scale. The construction of the Erie Canal had cut off the trade which Philadelphia and Baltimore had hitherto received from the West; and as the project of a canal from the city of Baltimore to the Ohio was regarded by many as impracticable, the merchants of that city, in 1827, procured the charter of the present Baltimore & Ohio Railroad. On the 4th of July, 1828, the construction of the railroad was begun, the first act being performed by the venerable Charles Carroll, of Carrollton, the only then surviving signer of the Declaration of Independence. At the close of the ceremony of breaking ground, Mr. Carroll said: "'I consider this among the most important acts of my life, second only to that of signing the Declaration of Independence, if even second to that.'

"In the fall of 1829, the laying of the rails within the city of Baltimore was begun. On the 22d of May, 1830, the first section of fifteen miles, to Ellicott's Mills, was opened.

"The next important railroad was the South Carolina,* begun in 1830, and opened for traffic in 1833 for its whole length (135 miles). At that time, it was the longest continous line of railroad in the world. The construction of the Mohawk & Hudson Railroad, now a part of the New York Central, was begun in 1830. It was opened (17 miles) in 1831. The Saratoga & Schenectady Railroad (21½ miles) was opened in the following year; the Paterson & Hudson River Railroad was chartered in January, 1831, construction on it was commenced in 1832, and it was opened in 1834; the Cayuga & Susquehanna (34 miles), connecting the Susquehanna river with the Cayuga Lake, was opened in 1834; and the Rensselaer & Saratoga (25 miles) in 1835. In New Jersey, that portion of the Camden and Amboy extending from Bordentown to Hightstown (14 miles) was opened on the 22d of December, 1833; and between Hightstown and South Amboy (47½ miles) in 1834. In Pennsylvania, a considerable extent of line for the transportation of coal had been constructed previous to 1835. In 1834, the Philadelphia & Columbia (82 miles) and the Portage Railroad (36 miles), both forming a part of the system of public works undertaken by the State of Pennsylvania, were opened. The completion of these gave that State a continuous line, made up of canal and railroad, from Philadelphia to the Ohio River at Pittsburgh. The total mileage of railroad constructed in the State of New York up to, and including, 1835, was 265 miles, or more than one-quarter of the whole extent of line then in use in the United States. In 1833, the Baltimore & Ohio Railroad was extended as far west as Harper's Ferry (81 miles). In the same year the Washington branch (30 miles) was also completed. In Massachusetts, in 1835, the Boston & Worcester Railroad (44 miles), the Boston & Providence (41 miles), and the Boston & Lowell (26 miles) were all opened for business. The total mileage in operation in all the States at the close of that year was 1,098 miles."

The preceding sketch of the early history of railroads in this country, is given to show the extent of railroad construction at the time that Mr. Rogers determined to undertake the manufacture of locomotives.

Chapter III.

THE EARLY HISTORY OF LOCOMOTIVES IN THIS COUNTRY.

In the latter part of the year 1827, the Delaware & Hudson Canal Company decided to have built in England three locomotives, for their line of railroad from Honesdale to Carbondale. This action was taken on the report of the chief engineer of the road, Mr. John B. Jervis; and Mr. Horatio Allen, then a resident engineer on the line, was deputized to go to England and have the engines built on plans to be decided by him when in England. He arrived there early in 1828, and ordered one engine from Foster Rastrick & Co., of Stourbridge. This was the "Stourbridge Lion" (Fig. 2). Two other engines were ordered from Stephenson & Co., Newcastle.

In a pamphlet with the title "The Railroad Era," written by Mr. Allen in 1884, he says:

"The two locomotives from Stephenson that were in New York early in the year 1829, and therefore prior to the trial of the locomotive 'Rocket' in October of that year, were identical in boiler, engines, plan and appurtenances with the 'Rocket' (Fig. 3); and if one of the two engines in hand ready to be sent had been the one used on August 9th, 1829, the performance of the 'Rocket' in England would have been anticipated in this country.

"The three locomotives were received in New York in the winter of 1828 and 1829. One of each kind was set up, with the wheels *not* in contact with the ground, and steam being raised, every operation of the locomotive was fully presented, except that of onward motion."

None of these engines were sent to the road for which they

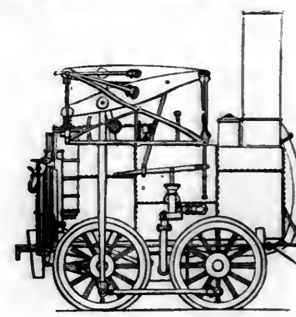


Fig. 2.

were intended, until the following spring. The "Stourbridge Lion," so far as is known, was the only one which was ever placed on the road. It was not tried until August 9th, 1829, and was then run by Horatio Allen, who has the honor of being the first person who ever ran a locomotive in America.

This engine, it was said, was too heavy for the road, and was used only a short time. It is a singular fact that it is not now

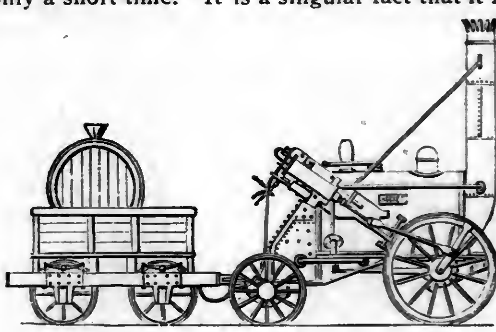


Fig. 3.

(1886) known what became of the two engines built by Stephenson & Co., and which were in every essential similar to the celebrated "Rocket."

In August, 1830, Peter Cooper tried his 'model of experimental locomotive engine" (represented by Fig. 4) on the Baltimore & Ohio Railroad. This engine had but one working cylinder of 3¼ inches diameter, and 14½ inches stroke of pis-

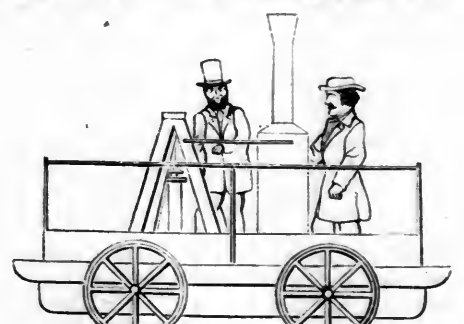


Fig. 4.

ton. The engine was tried on August 28th, 1830. In the same year, the South Carolina Railroad Company contracted with Mr. E. L. Miller to build a locomotive, which was named the "Best Friend," for the South Carolina Railroad Company. This engine (shown by Fig. 5) was put into service in November, 1830, and was the first locomotive ever built in America for actual service upon a railroad.

A locomotive called "The South Carolina" (Fig. 6), designed by Horatio Allen, was built for the South Carolina Railroad by the West Point Foundry Association, in the year 1831. The boiler had its fire-box in the middle, with a pair of

* The original charter of the South Carolina Railroad was granted December 19th, 1827. This was not satisfactory to some of the citizens of Charleston, and a new bill was reported to the legislature on the 22d of January, 1828, and passed on the 29th of the same month. The stockholders organized as a company on the 12th of May, 1828.

barrels (four in all) extending each way, with a chimney at each end. The engine had eight wheels, arranged in two trucks, one pair of driving-wheels, and one pair of leading wheels forming a truck. Each truck had one cylinder, which was in the middle of the engine and attached to the smoke-box. The driving axle had a crank in the middle to which the connecting rod was attached by a ball-joint. The trucks were connected to the engine by king-bolts in the usual way.

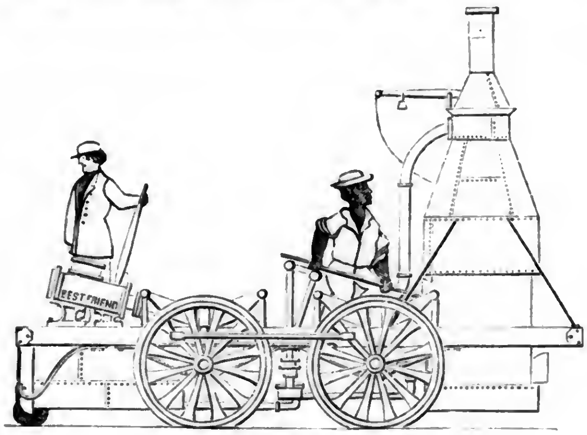


Fig. 5.

The "De Witt Clinton" (Fig. 7) was the third locomotive built by the West Point foundry Association. It was made for the Mohawk & Hudson Railroad, and was ordered by John B. Jervis, Esq. The first excursion trip with passengers, drawn by the "De Witt Clinton," was made from Albany to Schenectady, August 9th, 1831.

On January 4th, 1831, the Baltimore and Ohio Railroad offered the sum of $4,000 "for the most approved engine

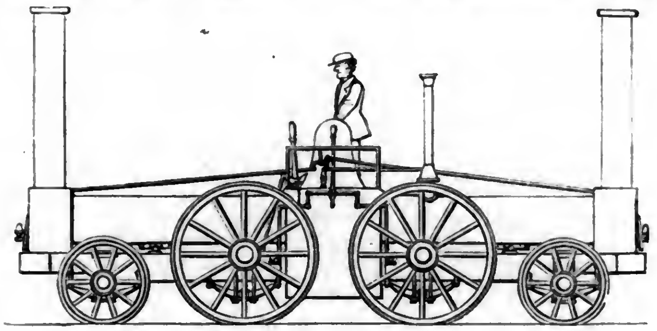


Fig. 6.

which shall be delivered for trial upon the road on or before the 1st of June, 1831—and $3,500 for the engine which shall be adjudged the next best."

Three or four locomotives, amongst them one with a rotary engine, built by Mr. Childs, of Philadelphia, entered into the competition during the summer of 1831. The only one of them, named the "York," which proved equal to the moderate performance required of them, was the one built by Messrs.

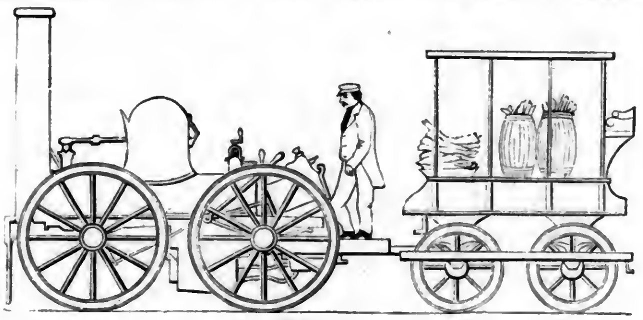


Fig. 7.

Davis & Gartner, two machinists of York, Pa. The engines had a vertical boiler and vertical cylinders, with four coupled wheels 30 inches in diameter. It was altered considerably after being placed on the road. The "Atlantic" was afterwards built by the same firm, and was the first of what were afterwards known as the grasshopper engines (Fig. 8), which were used for many years on the Baltimore & Ohio Railroad.

In August, 1831, the locomotive "John Bull" (Fig. 9), built by George & Robert Stephenson & Co., of Newcastle-upon-Tyne, was received in Philadelphia for the Camden and Amboy Railroad and Transportation Company. This is the old engine which was exhibited at the Centennial Exhibition in Philapelphia in 1876. In the winter of 1831 or 1832, three locomotives built by the same firm in England were received, and were put to work on the Newcastle & Frenchtown Railroad in Delaware.

The third edition of "Wood's Treatise on Railways," published in 1838, contains a tabular statement which gives the names and dimensions of engines built by R. Stephenson & Co., Newcastle-upon-Tyne, and the names of the railways for

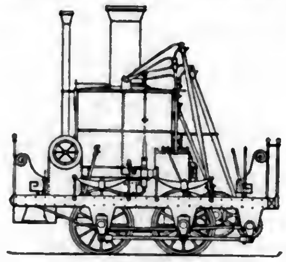


Fig. 8.

which they were built. This table contains the names of the following locomotives for American roads:

"Delaware," for Newcastle & Frenchtown Railroad.
"Maryland," " " " "
"Pennsylvania," " " " "
"No. 42," for Saratoga & Schenectady Railroad.
"H," and "Mohawk," for Mohawk & Hudson Railroad.
"Stevens," for New York.
"No. 52," for United States.
"Edgefield," for Charleston & Columbia Railroad.

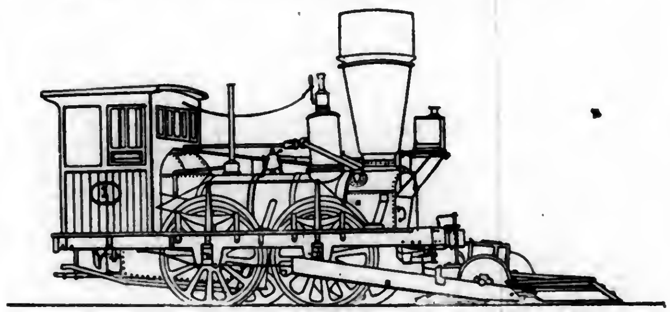


Fig. 9.

"Brother Jonathan," for Mohawk & Hudson Railroad.
"No. 61." " " " " "
"No. 75," for Saratoga & Schenectady Railroad.
"Wm. Aiken," for Charleston & Columbia Railroad.
"No. 99," " " " " "
"No. 104," for Pennsylvania Railroad.
"No. 105," " " "
"No. 106," " Columbia "

No dates are given in the table, but all of these sixteen engines must have been built before 1838. Most of them were

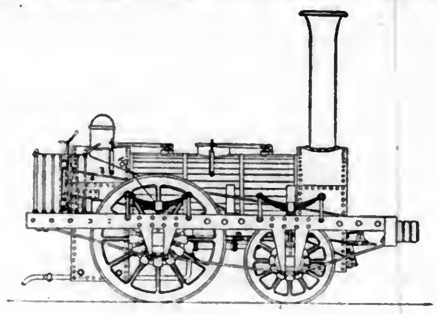


Fig. 10.

probably of what was known as the "Planet" class (shown by Fig. 10), which is the form of engine that succeeded the "Rocket," and the only one which the Stephensons built for some years after its adoption. These locomotives, which were imported from England, doubtless, to a very considerable extent, furnished the types and patterns from which the engines which were afterwards built here were fashioned. But American designs very soon began to depart from their British prototypes, and a process of adaptation to the existing conditions of the railroads in this country followed, which afterwards "differentiated" the American locomotives more and

more from those built in Great Britain. Until recently, a marked feature of difference between American and English locomotives has been the use of the truck under the former. Its use was proposed by Mr. Horatio Allen, in a report, dated May 16th, 1831, which he made to the South Carolina Canal & Railroad Company, of which he was then the chief engineer. The locomotive with two trucks (shown by Fig. 6) was built from his design in the latter part of 1831, and was put into operation on the South Carolina Railroad in the early part of 1832. In the latter part of the year 1831, the late John B. Jervis invented what he called "a new plan of frame, with a bearing carriage, for a locomotive engine, for the use of the Mohawk & Hudson Railroad (represented by Fig. 11), which was constructed and put on the road in the season of 1832."

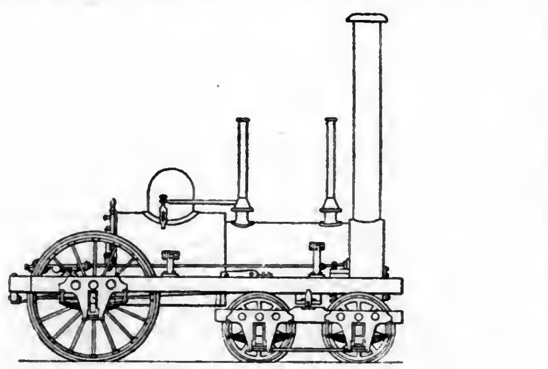


Fig. 11.

A truck was also devised by Ross Winans and applied to a locomotive on the Baltimore & Susquehanna Railroad (now the Northern Central) in the latter part of 1832. In a letter published in the AMERICAN RAILROAD JOURNAL of July 27th, 1833, Mr. Jervis describes the objects aimed at in the use of the truck, as follows :

"The leading objects I had in view, in the general arrangement of the plan of the engine, did not contemplate any improvement in the power over those heretofore constructed by Stephenson & Co.; * but to make an engine that would be better adapted to railroads of less strength than are common in England ; that would travel with more ease to itself and to the rail on curved roads ; that would be less affected by inequalities of the rail than is attained by the arrangement in the most approved engines."

The effectiveness of the truck in accomplishing what it was intended for was at once recognized, and its almost general adoption on American locomotives followed.

In the year 1833, Judge Dickerson, then president of the Paterson & Hudson River Railroad, ordered a locomotive, which was called the "McNeill," from George Stephenson, which was to be as good as possible, without regard to cost. It arrived and was put in operation in the year 1834. The cylinders were 9 inches diameter by 18 inches stroke, and the engine had one pair of driving-wheels five feet in diameter, which were behind the fire-box. The axle was cranked, and the cranks were close to the wheels ; there was room for the connecting rods to pass by the outside of the furnace. The front end was supported by a four-wheeled truck ; the fire-box and tubes were of copper. The engine continued in use many years and was said to be very fast, and was finally sold to a western railroad, the business of the Paterson & Hudson River Railroad having grown beyond the engine's capacity.

There may have been other English engines, of which there is no record, imported into this country about this time, but, as already stated there is no doubt that to a very considerable extent the English engines were the models from which American designers received many suggestions ; but, as will be shown, they very soon began to depart from the original types, and the development of the locomotive here was quite distinct from that which it had in Europe.

CHAPTER IV.

HISTORY OF LOCOMOTIVE BUILDING AT THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

PREPARATION for locomotive building in Paterson had been made as early as 1833 by Messrs. Paul & Beggs, in their shop near that of Mr. Rogers. They had a small engine nearly completed when their building took fire and was consumed, and the locomotive destroyed.

In 1835 some buildings were begun by Messrs. Rogers, Ketchum & Grosvenor, with a view to the manufacture of locomotives.

The first locomotive, the "Sandusky," Fig. 12, which the firm built, was not completed until 1837. It was intended for the New Jersey Railroad & Transportation Company. The engine was 4 feet 10 inches gauge, the same as that of the line for which it was built. It had cylinders 11 inches diameter by 16 inches stroke, with one pair of driving-wheels of 4 feet 6 inches diameter, which were placed in front of the fire-box. The engine had a truck in front, with four 30-inch wheels. The cylinders were inside the frames and were connected to a crank-axle of the form shown in Fig. 13. The eccentrics were outside of the frame, and the eccentric rods extended back to rocking shafts which were located under the foot-board. The smoke-pipe was of the bonnet kind, and had a deflecting cone in its center. The edges of the cone were curled over so as to deflect the sparks downward, and thus prevent their passing through the wire bonnet, as well as preventing the bonnets from wearing out too fast.

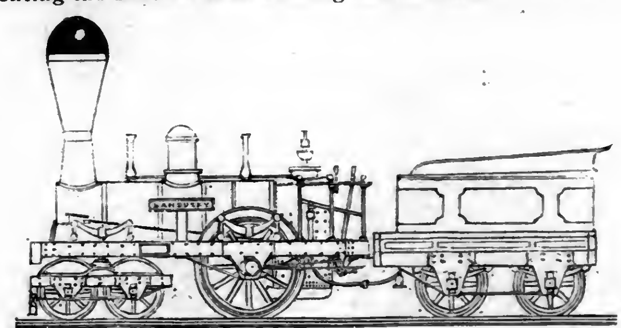


Fig. 12.

The driving-wheels of the engine were made of cast-iron, with hollow spokes and rims, which at the time was a remarkable novelty. The section of the spokes was of an oval form, and the rim of very much the same shape as that which is in common use at the present time. This kind of driving-wheel has since come into almost universal use in this country.

Another important improvement adopted by Mr. Rogers in the construction of this engine, was the counterbalancing the weight of the crank, connecting rods and piston. For this he filed a specification in the Patent Office, dated July 12th, 1837. It is described as follows in the specification :

"The nature of my improvement consists in providing the section of the wheel opposite to the crank with sufficient weight to counterbalance the crank and connecting rods, making the resistance of the engine less in starting and in running ; also preventing the irregularity of motion caused by that side of the wheels when the cranks are placed in the usual mode of fitting them up. The irregular motion which arises from not having the cranks and connecting rods balanced, is attended with much injury to the engine, and to the road, and with much loss of power."

In order to counterbalance the weight of the parts referred to, the rim of the wheel opposite the crank was cast solid, while the other part of it was made hollow. The importance of counterbalancing was not recognized as being necessary until several years after it had been introduced by Mr. Rogers, and when attention was drawn to it, many doubted the necessity of balancing anything more than the cranks.

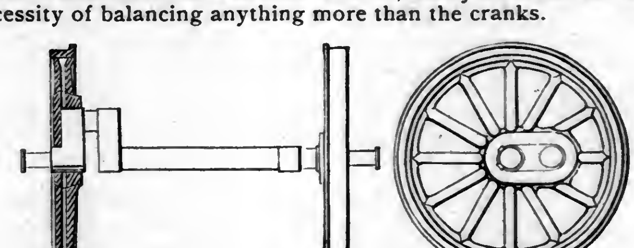


Fig. 13.

The trial trip of the "Sandusky" was made from Paterson to Jersey City and New Brunswick, and back, on the 6th of October, 1837, Mr. Timothy Smith acting as engineer. The performance of the engine was entirely satisfactory ; the gauge of the road was 4 feet 10 inches, the same as that of the New Jersey Railroad & Transportation Company, for which road the engine was intended. It was, however, bought for the Mad River & Lake Erie Railroad by its President, Mr. J. H. James, of Urbana, Ohio, and, on the 14th, it was shipped via canal and lake, in charge of Mr. Thomas Hogg, in the schooner *Sandusky*. Mr. Hogg had worked upon it from the commencement. It arrived at Sandusky, Nov. 17th, 1837, at which time not a foot of track had been laid. The road was built to suit the gauge of the engine, and the Legislature of Ohio passed an Act requiring all roads built in that State to be of 4 feet 10 inches gauge, the same as the engine "Sandusky."

The engine was used in the construction of the road until

* The truck was applied by Mr. Jervis to an engine built by Stephenson & Co., of England.

the 11th of April, 1838, when regular trips for the conveyance of passengers commenced between Belleview and Sandusky, a distance of 16 miles.

The engineer was Thomas Hogg, who ran the engine for three years, keeping it in repair. It continued in service many years, until engines of larger size were required to do the work.

The second locomotive built by Mr. Rogers was called the "Arresseoh No. 2." It was completed in February, 1838, for the New Jersey Railroad & Transportation Company. It was similar in design to the "Sandusky."

The third engine was named the "Clinton," and was built for the Lockport & Niagara Falls Railroad Company, and was delivered to it in April, 1838. It differed from the first engines in having cylinders which were 10 inches in diameter and 18 inches stroke, and the gauge was 4 feet 8½ inches. Both the driving and the truck wheels of this engine had hollow oval spokes, and hollow rims with wrought-iron tires. This engine was run by Wm. E. Cooper until November, 1843, when it was sold to the Toledo & Adrian Railroad for $6,500, the original cost. It was said by Mr. Cooper that when the engine was sold it was considered to be one of the best working engines in existence.

An engine called the "Experiment," was the next or the fourth locomotive turned out. It was made for the South Carolina Railroad, and was delivered in June, 1838. This engine differed from those previously built at these works, in having a smaller cylinder and longer stroke than usual.

The "Sandusky" was the type of the first four locomotives built by Messrs. Rogers, Ketchum & Grosvenor. In many respects they all resembled the Stephenson engines. They had inside cylinders and a crank-axle, but differed from English locomotives chiefly in having a truck instead of a pair of

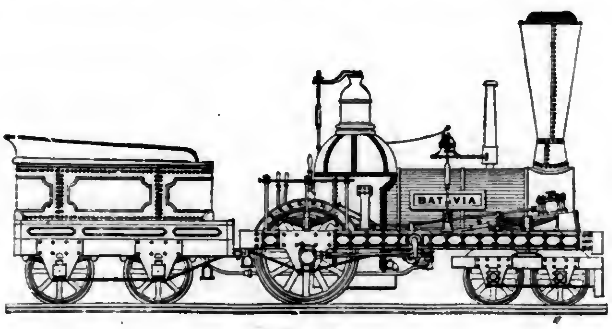


Fig. 14.

leading wheels. The driving-axles were in front of the fire-boxes, with the result that the overhang of the latter behind the axle brought an undue proportion of the weight of the engine on these axles.

To remedy the evil of an excessive amount of weight on the driving-axle, the latter was placed behind the fire-box in the fifth engine, called the "Batavia," Fig. 14, built at these works. When this was done, however, there was too little load on the driving-wheels, and an arrangement was provided for transferring part of the weight of the tender to them. The "Batavia" was built for the Tonawanda Railroad, and was completed in 1838. The shape of the furnace, in plan, was semi-circular at the rear part, and it had a hemispherical top surmounted with a dome. This form of fire-box was used as late as 1857.

In his early engines, besides using inside cylinders, Mr. Rogers also followed the plan which is still used in England, viz.: putting the cranks for parallel or coupling rods opposite to the main cranks. He soon found that this arrangement, while it had some advantages, such as requiring less counter-balance, caused the journals of the driving-axles to wear oval; he therefore adopted the plan of putting the cranks, for both main and outside rods, on the same side of the center of the axle.

The "state of the art" of locomotive building in this country in its infancy, is graphically described in the following articles, which appeared in the American Railroad Journal and Mechanic's Magazine of December 15th, 1839. In one of these the editor said:

"A few days ago, in company with one of the proprietors, we had the pleasure of a visit to, and inspection of the very extensive works of Messrs. Rogers, Ketchum & Grosvenor, at Paterson, New Jersey, for the construction of various kinds of machinery. Our attention was, of course, principally directed to the shops for the construction of locomotives, the main building of which is 200 feet long and three stories high, and another of equal length containing near 50 forges, most of which were in operation, notwithstanding the pressure of the times.

"We saw a number of engines in different states of forwardness, and though the general forms are those of 6-wheeled American engines in general, we were not a little gratified with several minor arrangements, new to us at least, which have been introduced by Mr. Rogers, and to which we shall briefly refer.

"The wire gauze of the smoke-pipe is protected by an inverted cone, placed in the axis of the pipe, a few inches below the wire gauze. The base of the cone is curled over so as to scatter the sparks over a large portion of the surface of the wire cloth, and to prevent the top of the spark-catcher from being burnt out before the rest of the wire cloth is materially injured; it also tends to throw the larger sparks down between the pipe and the casing, and will do something towards diminishing this standing reproach.

"The truck-frames, whether of wood or iron, were admirably stiffened by diagonal braces, and where the crank-axle is used, the large frame is very strongly plated in the manner of Stephenson's engines, the neglect of which till very lately has been, we are informed, a constant objection to the Philadelphia engines on the Long Island and Troy railroads.

"The wheels are of cast-iron, with wrought-iron tires; the spokes are round, and they, as well as the rims, are hollow, except where the crank-axle is used, when the rims are cast solid on one side so as to counter-balance the cranks.

"Our readers will probably remember an article on this subject in the Journal, Nos. 7 and 8, page 244, of the present volume, on 'Side Motion or Rocking,' by G. Heaton, where its success on the Birmingham Railroad has been complete.

"Mr. Rogers balanced his first engine wheels two and a half years since, and entered a specification, not with the intention of taking out a patent, but to prevent anyone else from doing so; and thus deprive the community of the benefit which Mr. Rogers was desirous of conferring, and which we understand other makers are now availing themselves of. The advantages are fully explained in the article referred to.

"When the crank-axle is used, the eccentric rods and the cranks of the rock-shafts are placed on the outside, where they are easily got at, and where they are not crowded into the smallest possible space, as with the ordinary arrangement. For this, also, a specification was entered with the same object as in the preceding case.

"But we were most pleased with the arrangement of levers to which the eccentric rods are fastened, and thus the reversing depends on no contingency, for the rods are forced in and out of gear; a single handle only is required to manage the engine much more rapidly and efficiently than by the ordinary mode. The boilers are 8 feet long, for an 8-ton engine, and with 120 flues, the usual length of the former being, we believe, 7 feet, and the number of the latter about 80 or 90; by this deviation the area of heating surface is increased, and the heat remains longer in contact with the flues, while the addition to the weight is very trifling compared with the advantages derived from the saving of fuel.

"Mr. Baldwin, of Philadelphia, took out a patent some time since for a very ingenious mode of saving half the crank, by inserting the wrists into one of the spokes of the driving-wheels, and this has been very closely imitated by making one complete crank, and by letting one-half of it into a spoke which is cast larger than the others, with a receptacle for the purpose. This latter plan has been adopted by Mr. Rogers and others in this neighborhood, whilst the Boston machinists aim at bringing the two cranks as near together as possible. The relative merits of straight and cranked axles are so well pointed out in Mr. Wood's papers on locomotives in these numbers, that we shall merely beg leave to state that the plan of Mr. Baldwin and its imitation, appear to us to combine the liability to fracture of the crank-axle with the loss of heat, the exposure to accident, and the racking of frame and road ascribed to the straight axle, for the only difference is the thickness of the spoke; the loss of heat is the same in both, the protection against any serious accident is too trifling to be considered, whilst, with the cranks as close together as possible, the cylinders are completely protected.

"We offer these remarks as our views merely, and with all due deference to the superior skill of Messrs. Baldwin and Rogers. Mr. Rogers, in common with all other experienced machinists with whom we have conversed, is decidedly opposed to any increase of width of track beyond 5 feet, with the present weight of engine.

"As regards the power of the engines, they are able to slip the wheels when the rails are in the best state; this they do in common with all good American or English engines, consequently any accounts of extraordinary performance would be worse than superfluous, when we know that they will do all that any other engine whatever, with the same weight on the driving-wheels, possibly can do.

"As a last remark, we would observe that there is more finish on the engines of Messrs. Rogers, Ketchum & Grosvenor than we are in the habit of seeing; some parts usually painted black being highly polished. On the whole we consider their new establishment eminently calculated to add to the reputation of American locomotives, as it has for many years largely contributed to the character of American machinery for the manufacture of cotton and other objects."

Soon after he commenced building locomotives, Mr. Rogers became convinced that inside-connected engines, with crank-axles, were inferior in many respects to outside-connected ones, besides being more expensive to build and to keep in repair; he also became satisfied that in the matter of steadiness, the inside-connected had no advantage over the outside-connected engine, and that, with proper counterbalancing, the latter could be run as fast as required without any injurious oscillation; and also, that it required more skill to properly counterbalance inside-connected engines than outside ones. Therefore, he was an earnest advocate of this style of engine, and recommended outside connected-engines as better than inside-connected ones.

Fig. 15 represents the "Stockbridge," built in 1842, with outside cylinders. In this engine the driving-axle was placed in front of the fire-box, and a pair of trailing-wheels behind to carry the overhanging weight. The load on the driving-wheels was, of course, reduced by an amount equal to that carried by the trailing-wheels, so that this type of engine was also deficient in adhesion and power.

The next step which was made was to substitute a pair of driving-wheels for the trailing-wheels, and couple them with the main driving-wheels. This form of engine, shown by Fig. 16, was patented in 1836 by Henry R. Campbell, of Philadelphia, and was adopted by Mr. Rogers in 1844. This plan has since been so generally adopted in this country that it is now known as the "American" type. Fig. 17 represents an engine of this kind built at the Rogers Works in 1844. It had

four coupled driving-wheels and outside cylinders. the eccentrics were on the back axle, the pumps were full stroke, worked from the cross-heads. It had springs over the back axle bearings, and also in the centre of the levers which extended from the driving-axle to the centre of the truck on each side of the engine. The truck was pivoted and turned upon a centre pin fixed to the boiler; the arrangement did not give satisfaction, and was altered after a short trial. This engine was remarkable from the fact that it is the first example of the use of an equalizing-beam between the driving-wheels and truck.

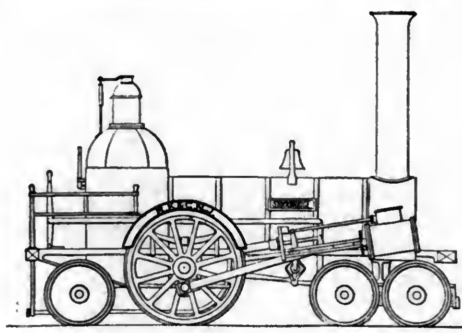


Fig. 15.

The engine shown by Fig. 18 was built in 1845, and had equalizing-levers between the driving-wheel springs; the truck had side bearings and springs over the sides of truck; the pumps had short stroke and were worked from the cross-head, as shown.

Fig. 19 shows an engine built in 1846 with the driving-wheels spread well apart. It had V hooks and independent cut-off on the back of the main valves; this was a favorite kind of engine for many years.

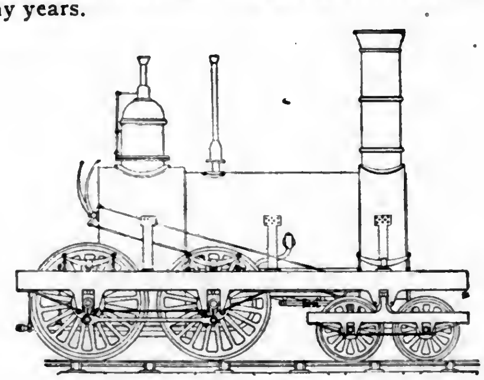


Fig. 16.

In 1848, Mr. Rogers was requested to furnish some engines with six-coupled wheels for the Savanilla Railroad in Cuba. He then designed and built the first ten-wheeled engines ever made at the Rogers Works. There is no drawing of these engines extant. They had, however, outside cylinders 15½ inches diameter by 20 inches stroke. The ten-wheeled engines which had been built previous to this time had inside cylinders and crank axles. The connecting rods of the engines for the Savanilla Railroad were made to take hold of the outside journal of the main crank-pin, which at that time was a new departure.

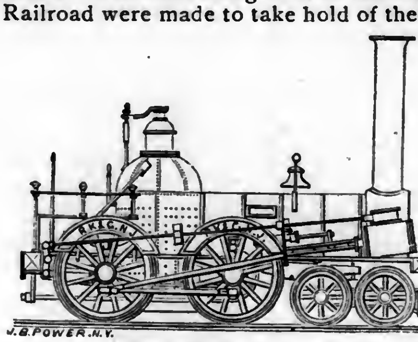


Fig. 17.

Fig. 20 represents a plan of ten-wheeled engine, with half-crank keyed on the driving-wheel, same as Baldwin's plan. This pattern of engine was built in 1848 after those for the Savanilla Railroad. The engine had outside bearings and equalizing-levers between the springs; it also had cranks on the axles outside the frames to which the coupling-rods were attached. A number of engines on this plan, with cylinders 17 × 22, were built for the New York & Erie Railroad. They all had independent cut-off valves.

Fig. 21 represents an inside-cylinder engine with full crank; the steam-chests were inclined sidewise, so that the valves could be readily got at. This was one of the improvements introduced by Thomas Rogers. The engine had V hooks and independent cut-off valves, and was built for the Paterson & Hudson River Railroad.

On the style of engine shown by Fig. 22, the shifting-link motion was introduced. Thomas Rogers was one of its earliest advocates, and did more toward its successful introduction on American locomotives than any other person. He was not only an early, but an earnest advocate of it, at a time when it was condemned by some of the most prominent engineers in the country. Time has amply proved all that he claimed for it, which was, that it is the most simple and efficient form of valve-gear that has ever been devised.

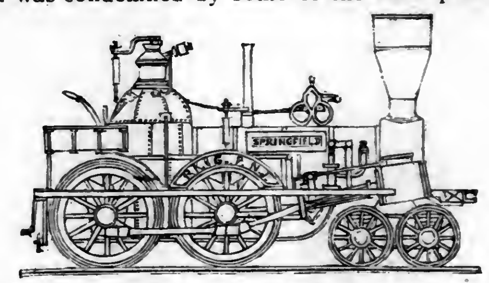


Fig. 18.

Fig. 23 represents a style of passenger engine which was first built in 1852. It had 15 × 22 inch cylinders, driving-wheels 5 feet in diameter. It had what may be called supplementary outside frames, which carried the running-board, cab, etc. It had shifting links, hung from below, and the truck axles had both inside and outside bearings. The form of engine represented by Fig. 24 was first built in 1853, and was for a long time very popular. The cylinders were 16 × 22 inches and the driving-wheels 5 feet diameter, although the size of the latter was varied somewhat in different engines.

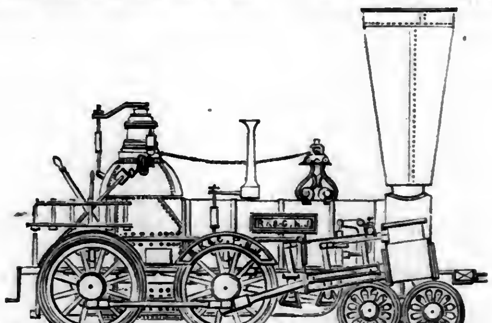


Fig. 19.

On the death of Mr. Thomas Rogers, which occurred in 1856, the business theretofore conducted by Rogers, Ketchum & Grosvenor was reörganized under a charter, with the title of The Rogers Locomotive & Machine Works, and Mr. William S. Hudson was then appointed superintendent. He was a prolific inventor and an excellent mechanic, and introduced many improvements in locomotive construction, which will be described further on.

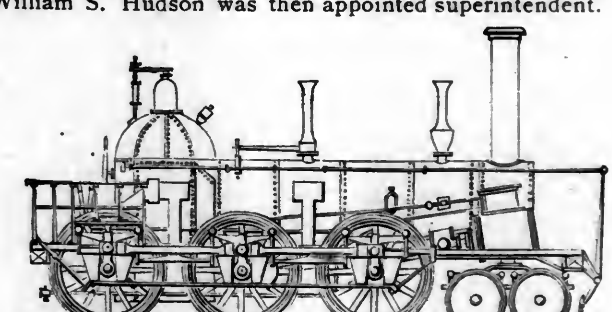


Fig. 20.

The first "Mogul" engine, Fig. 26, built at the Rogers Works, was completed in 1863. This plan of locomotive was made possible by the invention of the Bissell truck and the addition of the swing links to it by A. F. Smith, both of which will be described in another chapter. With a single axle-truck in front of the cylinder, the front driving-wheels can be placed

farther forward than they can be on a ten-wheeled engine with a four-wheeled truck, one axle of which is in front, and another behind the cylinders. Consequently "Mogul" engines have a larger proportion of their weight on the driving-wheels than ten-wheeled engines have, and this has brought the "Moguls" in favor for freight service.

The demand for more powerful locomotives naturally suggested coupling four pairs of wheels, and led to the "consolidation" type, which has eight driving-wheels coupled, and a pony truck in front of the cylinders. In 1880, the first "consolidation" engine built at the Rogers Works was completed.

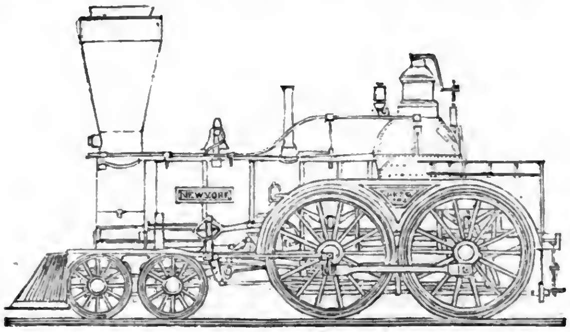


Fig. 21.

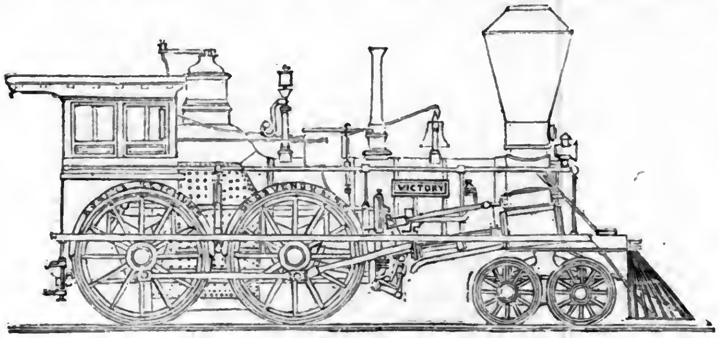


Fig. 22.

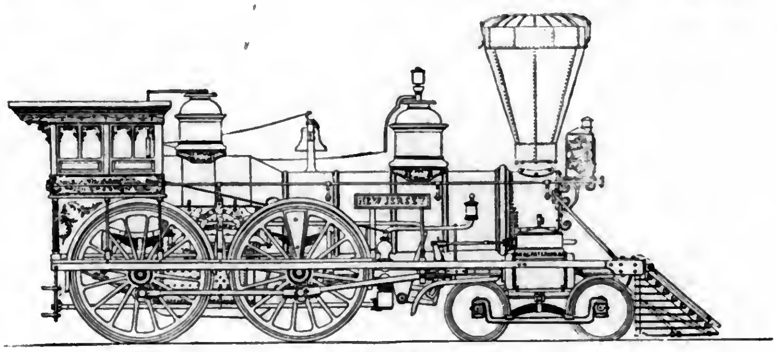


Fig. 23.

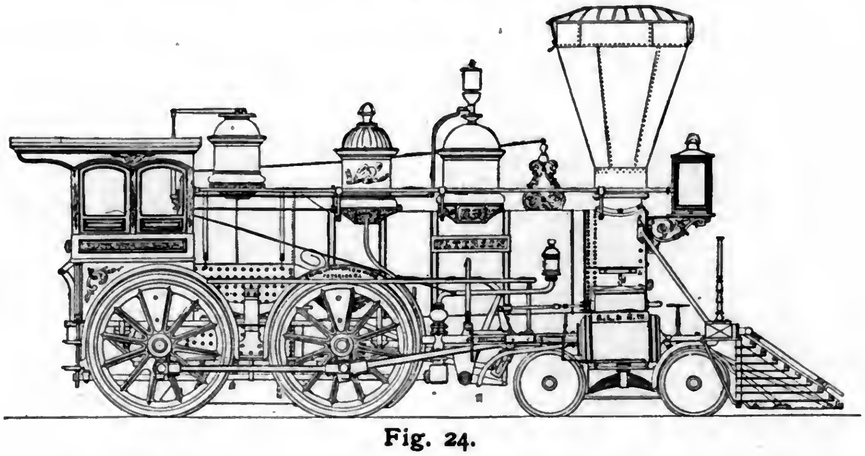


Fig. 24.

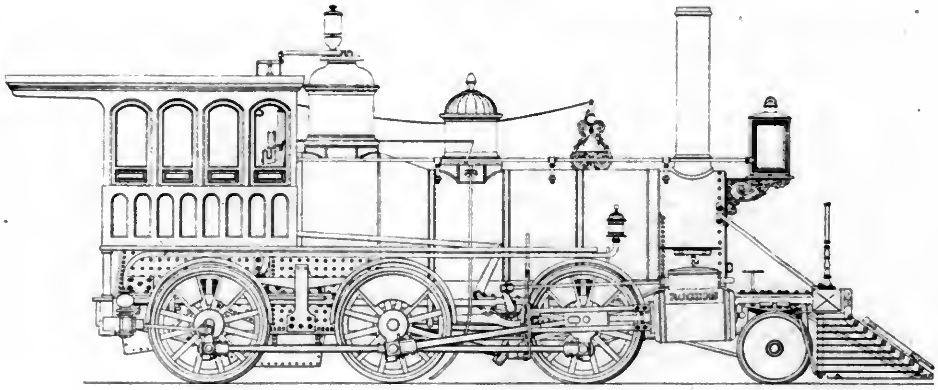


Fig. 26.

The types of engines which have been described, are the principal ones which have been evolved in this country for ordinary freight and passenger service. Besides these there has been a demand for locomotives for special service, such as switching, urban and suburban traffic, and for narrowness of which made it essential to design special methods of construction.

The most common plan used for switching-engines is that which has four-coupled wheels, both axles being placed between the furnace and smoke-box. Separate tenders are furnished with locomotives of this kind, or the tanks may be placed on top of the boilers.

When more powerful engines are required, six-coupled wheels are used with the axles, all between the furnace and smoke-box. Some six-coupled engines have been built with an axle behind the fire-box, but with this arrangement the overhanging weight of cylinder, smoke-box, etc., brings an

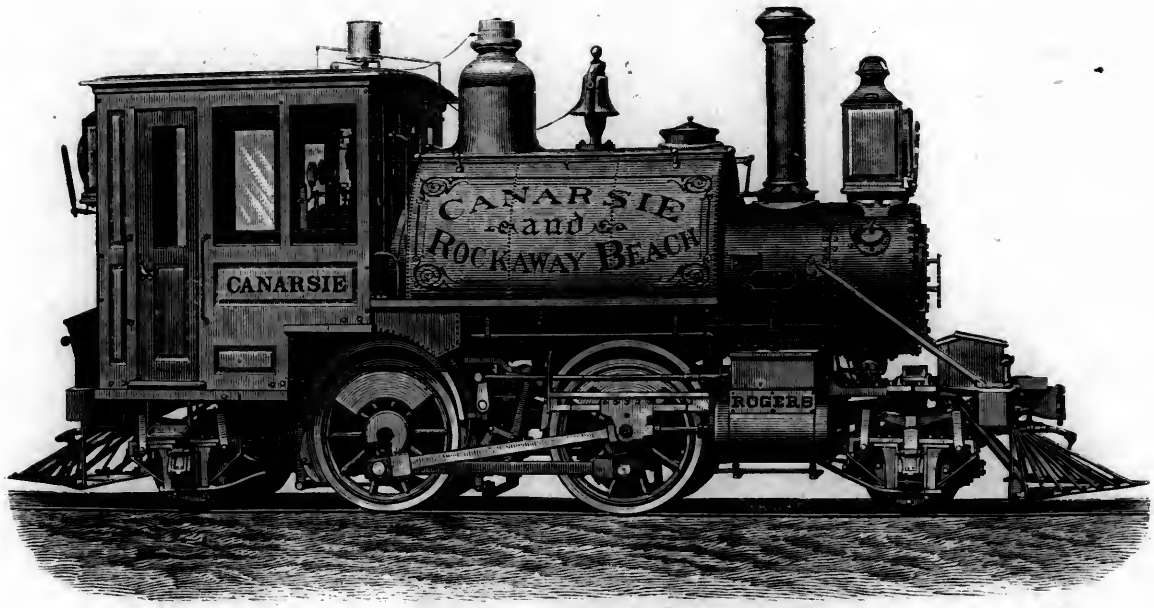


Plate I.

HUDSON'S EIGHT-WHEELED DOUDLE-END LOCOMOTIVE.

Plate II.

HUDSON'S TEN-WHEELED DOUBLE-END LOCOMOTIVE.

undue amount of weight on the front pair of wheels.

The advantage of locating the driving-axles between the furnace and smoke-box is, that the overhanging weight of the furnace behind balances that of the cylinders, smoke-box, etc., in front, and in this way the driving-wheels carry the whole weight of the engine, and it is equally distributed upon them. Placing the water-tank on top of the boiler is inconvenient and unsightly, and when in that position it is difficult to get room enough for an adequate supply of water, and there is also the disadvantage of a varying load on the driving-wheels, which may be excessive with the tank full, and insufficient when it is empty. For these reasons Mr. Hudson, after he became superintendent of the Rogers Works, turned his attention to devising methods of construction which would retain all the advantages of the arrangement of axles described, but which would at the same time give a longer wheel-base for steadiness, but with sufficient flexibility to enable the engine to run around sharp curves easily. The requirements of suburban and other traffic, in which engines must make short runs, had also created a demand for locomotives which could be conveniently and safely run both ways, and which would not require to be turned around at the end of each journey. Having these objects in view, Mr. Hudson, in 1867, designed and patented the plan of tank locomotive represented by Plate I, which soon became known as "Hudson's Double-Ender." In this, the two driving-axles were placed beteen the furnace and smoke-box, and a Bissell truck was placed at each end of the engine. Mr. Hudson's patent was dated May 7th, 1867, and was rëissued December 7th, 1875.

It will be seen that the water-tank of these engines was on top of the boiler. This arrangement was open to the objections which have been pointed out. To overcome these Mr. Hudson, in 1872, designed and patented the plan of engine represented by Plate II. In this the arrangement of the driving-axles and the front truck, excepting the equalizing arrangements, are the same as in the "Double-Ender" plan, but instead of a two-wheeled Bissell truck behind, a four-wheeled swing-motion truck was substituted, and the water-tank instead of being placed on top of the boilers, was placed over the four-wheeled truck. This arrangement was patented July 16th, 1872.

In 1866, Mr. M. N. Forney patented the plan embodied in the engine shown in Plate III. A number of engines of that kind have been built at the Rogers Locomotive Works for various roads. Whether a leading truck is essential for engines of this class has been a subject of a good deal of controversy among railroad engineers. To reconcile the views of the various parties to this dispute, the Rogers Works build locomotives either with or without the leading truck, as required, leaving to the purchaser and user the task of determining whether a leading truck is useful or not.

In 1872, Mr. Hudson took out seven patents for different plans of tank engines with trucks at each end. In all of them his system of equalizing levers between the trucks and driving-wheel springs, which is described in another chapter, was used, and his patents were chiefly for various applications of that system.

He also patented, in 1873, a plan for a compound locomotive. This had two outside cylinders in the usual position, the one being of larger diameter than the other. It was intended that, ordinarily, live steam from the boiler should be admitted to the small cylinder only, from which it exhausted into a super-heater in the smoke-box before it passed into the large cylinder on the opposite side. The steam-pipe was connected with the steam-chest of the large cylinder by another pipe of smaller diameter. Live steam could be admitted by the small pipe to the large cylinder, if required. This plan was never put into practice.

Mr. Hudson's death occurred on the 20th of July, 1881. He was then 72 years old.

The following extracts are taken from an account of his life, which appeared in the *Railroad Gazette* immediately after his death.

"He was born near the town of Derby, England, in 1809, and at an early age began to learn the trade of an engineer and machinist, serving part of his apprenticeship under George Stephenson. In 1833, when 24 years of age, he came to this country, and for a time found work in the engine room and machine shops attached to the Auburn State Prison in New York. He soon left that place, however, and engaged as a locomotive runner on the old Rochester & Auburn Railroad, now a portion of the New York Central. Subsequently he ran an engine on the Attica & Buffalo Railroad, and was made master mechanic of the road, which he left in 1852 to become superintendent of the locomotive works of Rogers, Ketchum & Grosvenor, at Paterson, N. J. In 1856, these works were incorporated as the Rogers Locomotive and Machine Works, and Mr. Hudson was made mechanical engineer and superintendent, a position which he held until his death. He succeeded Mr. Thomas Rogers, who was the founder of these works, and who probably did more than any other man to develop the design and improve the construction of the American locomotive as it is to-day. But Mr. Hudson took up the work where Mr. Rogers left it, and during the 30 years that Mr. Hudson occupied the position of head of the mechanical department of this establishment, he made many improvements in the locomotives built there, chiefly of a kind which are the result of simplifying details, adopting better methods of putting work together, and making the engines more substantial and more serviceable. He studied, as probably no other locomotive builder did, the performance of the engines he built. He was constantly looking out for their weak points, and it was said by the present head of the establishment, that Mr. Hudson was always more concerned about building a good engine than he was in making a good profit."

(*To be continued.*)

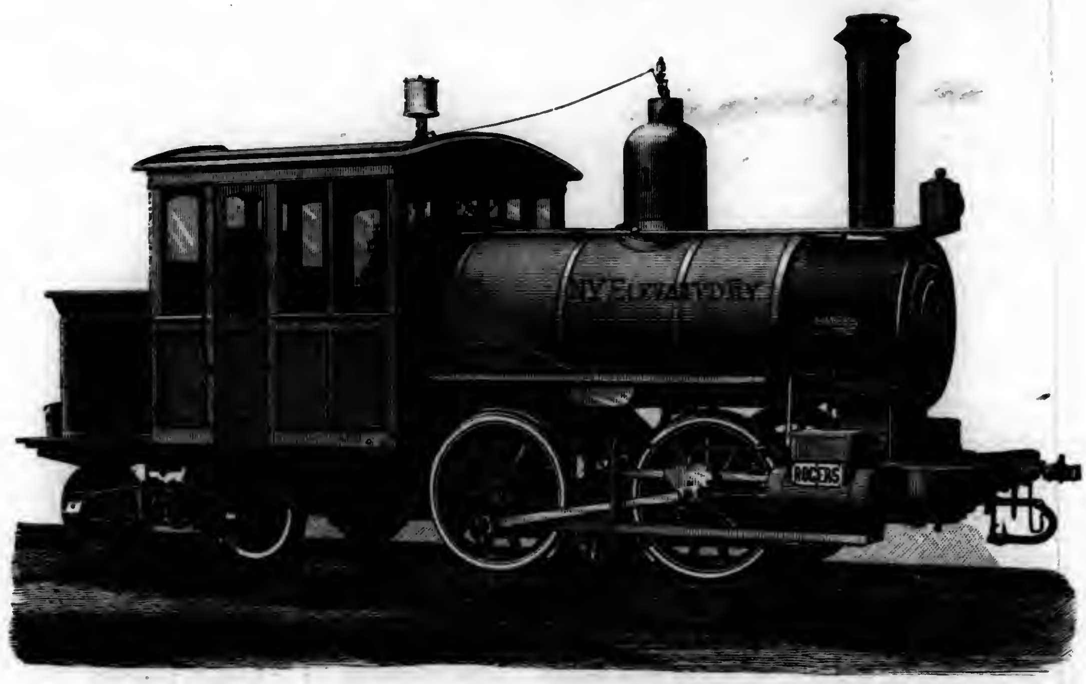


Plate III.

FORNEY LOCOMOTIVE.

Mr. Stevenson Towle has been appointed as an expert to examine and report on the system of sewerage now in use in Central Park, New York.

Mr. Virgil H. Bogue, lately with the Nothern Pacific, has been made chief engineer of the Union Pacific Railway, succeeding Mr. Blickensderfer, who has been chief engineer since 1879. The change was made with the sole view of increasing the engineering staff, Mr. Blickensderfer still ermaining with the company as consulting engineer.

THE RAILROAD AND

ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 23 MURRAY STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

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NEW YORK, FEBRUARY, 1887.

THE death of Sir Joseph Whitworth, which is recorded in another column, calls attention to the fact that his great reputation as a mechanical engineer, and the fortune which he made, were largely due to his early recognition of the value of accuracy in mechanical work. He saw that the methods of testing work then in use were loose and inaccurate, and set himself to work to improve them, with the success of which we all know.

RAILROAD building in the United States this year, from present indications, will include a number of lines already actually begun by companies of sufficient financial standing to secure their completion, and also many minor extensions planned, and very likely to be built. The greater part of this mileage, it may be noted, will be built by old companies to complete or extend their present systems. Of new projects there are an enormous number coming forward, but, as usual, by far the greater part of these will never get beyond the paper stage of existence.

The increased prices of railroad material may check, in some degree, the tendency to extension, but there is little doubt that this year, as well as last, will be a year of activity in railroad construction and in all the trades dependent upon it.

THE narrow gauge, for which so great a future was predicted by its advocates a few years ago, is gradually disappearing in this country. During the past month the St. Louis, Arkansas & Texas Company changed its Texas Division from 3 feet to standard, thus completing its abandonment of the narrow gauge, its lines in Missouri and Arkansas having been changed some months ago. Two lines of considerable mileage remain east of the Mississippi, the Cleveland & Canton, in Ohio, and the Toledo, St. Louis & Kansas City; both of these are to be changed to standard as soon as the money needed can be raised.

By the close of the present year the Denver & Rio Grande will be, in all probability, the only railroad of any importance still adhering to the 3 feet gauge, and the company is not likely to make any change for several years to come, as its location and circumstances are so peculiar that it would not be justified in spending money at present for this purpose.

That a railroad of standard gauge is not only possible but also preferable in a difficult mountain country, is in process of demonstration by the Colorado Midland Company, which is now building a standard-gauge line from Leadville to Aspen, in Colorado. This line will come into direct competition with the narrow gauge of the Denver & Rio Grande, and will parallel one of its most important branches.

THE reports of the New York City railroads to the State Railroad Commission, which are for the year ending September 30, show that last year they carried in all 325,142,075 passengers, which is an average of 890,800 per day. Of this total the four lines of the Manhattan Elevated road carried 115,109,591, or 35½ per cent., while the surface lines carried 210,032,484, or 64½ per cent. This proportion did not vary greatly from the preceding year, and shows that the surface roads still continued to carry the larger share of the passengers. If the passenger mileage could be given the proportion would undoubtedly be changed considerably in favor of the elevated lines, which carry the greater part of the long-distance travel.

It is to be remembered that the year covered by these reports does not include any of the time since the general reduction of elevated fares. For about one-third of the year the fare on the two lines of least traffic was five cents, but the reduction from ten to five cents (outside of the commission hours) was not made until after the close of the year on the two more important lines. That this reduction has largely increased the travel on the elevated roads outside of the commission hours, and especially the short-distance travel, there is no doubt. Much of the additional business has been taken away from the surface roads, but a considerable part must come from that growth of the passenger movement which results partly from the actual increase of population, and partly from the increasing tendency "up-town," which has been very marked for the last two or three years.

The proper management of a passenger movement, which will before long reach an average of one million a day, is a problem which will task the best abilities of engineers and railroad managers.

HEATING RAILROAD CARS.

THE recent accidents which have occurred on the Baltimore & Ohio, and the Boston & Albany Railroads, in which a number of persons were burned to death, have, with renewed and horrible emphasis urged the subject to the attention of railroad managers and the public. The managers of, probably, a great majority of the railroads of the country are anxious to find a car-heater which will remove the danger which must be incurred so long as the fire which warms the cars is carried inside of them, and which will be free from the practical difficulties which have attended the use of the various plans which have been devised for dispensing with stoves. At the January meeting of the New England Club—the proceedings of which are reported on another page—this subject was discussed. There were present a considerable

number of experienced railroad men, and a half dozen or more of inventors of plans for heating cars. As will be seen from the report of the discussion, there were nearly as many different views of the subject as there were speakers. All, with perhaps one exception, were agreed however, that the fire for warming cars should not be inside of them.

It was also brought out by the discussion, that the amount of steam required to heat a train of cars, is only a small fraction of that which can be generated in a locomotive boiler. One of the speakers gave the heating surface in a Baker heater at 5.6 square feet, so that a train of 12 cars would have a total heating surface in its heaters of $5.6 \times 12 = 67.2$ square feet. An engine capable of hauling such a train would have about 12,000 square feet of heating surface in its boiler. But owing to the forced draft and other causes, probably a much greater amount of heat is transmitted through a square foot of heating surface in a locomotive boiler, than is conducted through the same area in a Baker heater, so that locomotive boiler heating surface has a much greater value than that in a car heater, from which it follows that only a small fraction of the capacity of the locomotive boiler—probably less than a half of one per cent.—is required to heat a train of 12 cars. This fact is important, because it is generally believed, and is often asserted, by master mechanics and those who should know, that locomotives cannot make steam enough to draw a heavy train, and heat a train of cars too. If the steam required to warm the cars is so small a proportion of that which a locomotive boiler can generate, then the difference between good firing and bad would compensate for the drain on the boiler for heating purposes. If these are the facts in the case, then the objection so often urged to heating with steam from the locomotive has a very slight foundation.

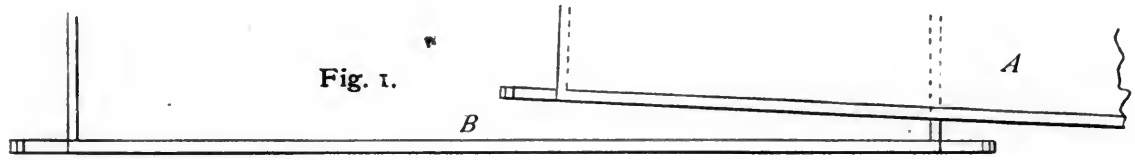


Fig. 1.

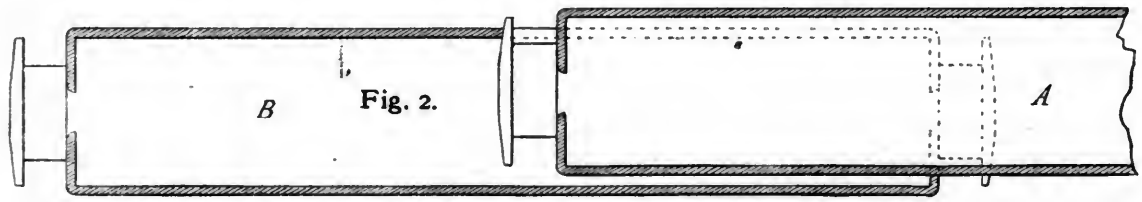


Fig. 2.

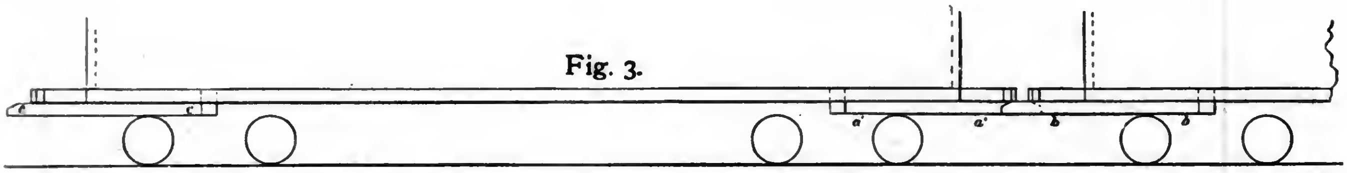


Fig. 3.

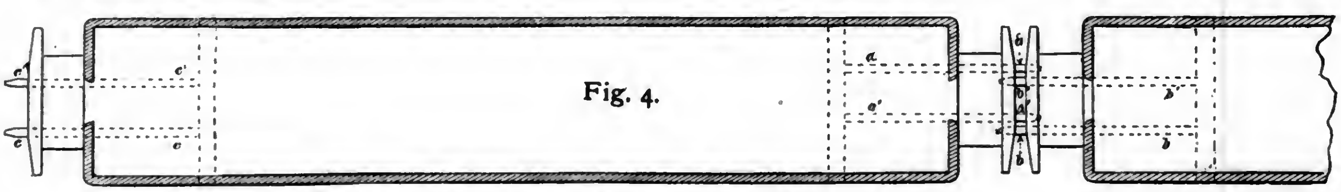


Fig. 4.

There are, though, other objections to this method of heating, which were very clearly stated by Mr. Depew. President of the New York Central Railroad, in a recent interview with a reporter of the New York *Tribune* in which Mr. Depew said:

"We make up trains here at Forty-second st., and before the train goes out of the station the engine may be blocks off. It is not always possible to have an engine attached to a waiting car or a train simply to give heat. Another objection to steam is that after a train has left New York for example, it will pick up additional cars at Poughkeepsie, Albany, Utica, Syracuse and so on. These cars have been waiting in these stations in advance of the coming of the train to accommodate passengers and save time. Often they are sleepers in which persons have gone to bed early. They must be kept warm, and how is that warmth to be had from an engine drawing a train miles away? It has been proposed to have a special boiler attached to the baggage car, with a special attendant. This would give heat to the complete train, but I don't know that the plan has ever been put into any kind of successful operation. What must be devised is a source of heat for each car, without the use of fire."

There is, besides the difficulties stated by Mr. Depew that of the flexible connections for the steam pipes between the cars. These are liable to burst, leak or freeze up, and when rubber hose is used, it must be replaced often. These objections may not be prohibitory of the use of the system, but they are serious.

Sometimes when a problem of this kind is presented, the solution may be found very close at hand. It may be, that in this case, the method which is so commonly used for heating houses with warmed air, could be satisfactorily adapted to heating cars. In houses, a stove is placed below the floor, fresh air is admitted to a casing surrounding the stove, and this is distributed by suitable flues and

openings to the apartments above. When this system has been applied to cars, it has usually been arranged so that the attendants were obliged to go outside of the train, to regulate and replenish the fire. To this there are loud complaints and objections from the attendants, and their opposition seems to be the most serious difficulty there is in the way of its use. If, then, it were possible to attach a stove below the floor, and feed and regulate the fire from the inside, then the comfort of the brakeman and the porter, would not be seriously disturbed in the performance of their duties, and the objection to the system which has been mentioned would be removed.

If we look about for a stove suited for this service, we find that one of the ordinary base-burning type is admirably adapted for the purpose. It can be attached to the floor of the car, and communication be made, so that it can be fed from above, or from the inside of the car. Mechanism can readily be devised for shaking the grate and regulating the dampers. The whole could then be enclosed in a strong sheet-iron casing, covered with some non-conducting material, to prevent the heat from being conducted away. By suitable flues fresh cold air can be admitted between the casing and the stove, and when it is warmed it can be conducted to, and distributed in the car by other flues, as is often done now in both cars and houses. There is nothing which is novel or untried in the appliances which are proposed. The system is in general use in houses, and to a limited extent in cars. It is true it has in some cases failed in cars, for want of proper attention, or knowledge of the construction of some of the details. Stoves which are so complicated in their construction that they are never used in houses, are sometimes put under cars with the vain hope that the intelligence of the brakeman or the porter will master their mysteries. Now, the first requisite of a car stove is, that it should be simple, and the more it resembles an ordinary house stove the better, because then the knowledge which the attendants acquire at home, in managing their own stoves enables them to take proper care of those which warm the cars. A complicated stove is potentially condemned before it is applied to a car.

Next, if the car is heated by warmed air it is essential that, within somewhat wide limits, the supply of cold air admitted to the stove, and, after it is warmed, to the car, should not be either too great or too small. If it is admitted by a fixed hood on top of the car either too much air will enter when the wind is ahead, or too little when it blows from the side. It is, therefore, desirable that a revolving hood should be used, with a vane attached so as to be directed towards the wind. If this is done a comparatively small opening—with about 30 or 40 square inches of area—will be found sufficient.

Care must also be taken to distribute the warmed air in the car properly. Instead of using registers in the flues, it seems to be a much better plan to make the flue which supplies the warmed air with a larger number of small perforations. The number of these should increase the farther the flue is from the source of the supply of air, because at the far end of the flue the pressure of the air is reduced, and a smaller quantity will therefore flow through the openings.

It is objected to this method of heating, that the stoves are still a source of danger, as they are attached to the cars. To this it may be answered, that in case of an accident, if the stove is knocked off the car, it ceases to be a source of danger, and, by covering the bottom of the car with sheet-iron, it can be protected from the fire in the stove so long as the latter is not broken loose. It is true that in accidents like that at Ashtabula, when the cars are run, or fall, on top of each other, the stoves might then set fire to the cars, but in nearly all cases it would lessen the risk of burning if the stoves were inside the cars, where the fire could be reached and extinguished, instead of outside of them, where it is inaccessible. As an experienced car-builder remarked at the Boston meeting, he "would much rather take his chances in an accident with the stoves below the car than he would if they were inside." The opening inside of the car for feeding the fire could readily be made secure with a suitable cover.

The danger from burning up in accidents nearly always arises from passengers being fastened in the wreck and unable to escape. In the recent and in many other accidents this was due to the telescoping of the cars. Whatever lessens the danger of that, therefore diminishes the risk of persons being burned.

It was supposed that when the Miller platform was introduced that it would entirely prevent the telescoping of cars; but recent accidents have shown that such is not the case. No doubt the Miller platform will resist shocks which would have crushed the old-fashioned cars which were used before it was introduced; but what generally occurs in collisions now is that the floor of the one car mounts above that of the other, as shown in Fig. 1. The position of the two car bodies is shown in a plan view in Fig. 2. It will be seen that when the cars get into this position, that the only thing which resists the car A from crushing or telescoping with B, is the side *s s*. This consists of posts and panels and has very litttle strength. If, however, the floors of the cars could be kept in line, or the one be prevented from raising above the other, then the shock would be resisted by the longitudinal sills in the floor which have a great deal of strength. What is needed, therefore, is some device to keep the floors of the cars in line, and prevent the one from raising above the other. Happily, we have not far to go to find such a device. The Blackstone platform and coupler have been in use on the Chicago & Alton Railroad for some fifteen years or more. Of the coupler no other mention need be made. The peculiar feature of the platform referred to is shown by Fig. 3, which is a side view, and Fig. 4, a plan of the floor framing. At each end of the cars, two safety beams, A A′ and B B′, which project beyond the buffer-beams, are fastened below the floor-sills. The safety-beams are not placed at equal distances from the center of the car, but one is further from it than the other, so that when one car adjoins the other, as shown on the right side of Fig. 4, the safety-beams interlock, as shown. It will also be seen that those in the one car project under the buffer-beam of the other, so that the one cannot raise up without taking the other with it. In this way the floors are kept in line and the longitudinal beams must resist the shock of collision instead of one side only, which has little more capacity of doing so than the paper in hoops has of opposing the leaps of a circus-rider.

These safety-beams are the invention of Mr. Blackstone, President of the Chicago & Alton Railroad Company. As safety-guards, in case of accident, they appear to have as much value as the Miller platform, although there is no reason why they should not be used conjointly. Prob-

ably if Mr. Blackstone had urged the adoption of his invention with the same vigor, and with the same methods, that were employed to make the Miller platform known, the former would now be as generally used as the latter is. There is little doubt that if the Blackstone device had been adopted, that we would have been spared the horrors of some of the accidents that have occurred in recent years.

NEW PUBLICATIONS.

"A SKETCH OF THE LIFE AND WORKS OF GEORGE W. WHISTLER, C. E."—*By George L. Vose, President of the Boston Society of Civil Engineers.* Boston: Lee & Shepard.

This little book is a brief history of one of the early and most noted of American engineers. It is printed in a very luxurious manner and is prefaced with a portrait apparently some kind of photo-copy of a lithograph. The author has collected together the important events and work of the subject of his memoir, which to the rising generation of engineers, are probably entirely unknown. In fact, the time appears to be not far off, when a career like that of Major Whistler's will have more or less of romantic interest, from the fact that such professional experience will be quite obsolete. Engineering is every day becoming more and more specialized. The man who locates a railroad no longer designs the bridges, and firms and companies confine themselves exclusively to building either wood, iron or stone structures. This process of differentiation goes on continually, and there are makers who devote themselves exclusively to the manufacture of one kind of car-wheels or one particular form of springs for car-seats.

In the early days of railroads, there were no engineers, even of the kind into which Major Whistler and his professional cotemporaries developed. There were only military engineers, and consequently when some of these were detailed for work which was not military, the term "civil engineer" had to be invented to distinguish those who were no longer military. In 1828, the Baltimore & Ohio Railroad made a special request upon the Army Department for the services of Lieut. Whistler, and he with several others were sent to England to examine the railroads in that country. He was afterwards engaged on various railroads and canals, and in 1842 he received an offer from the Emperor of Russia to act as consulting engineer of the road to be built from St. Petersburg to Moscow. He remained in that service until his death in 1849.

Of his professional ability, Prof. Vose writes that "he was eminently a practical man, remarkable for steadiness of judgment, and for sound business sense. Whatever he did was so well done, that he was naturally followed as a model by these who were seeking a high standard. Others may have excelled in extraordinary boldness, or in some remarkable specialty; but in all that rounds out the perfect engineer, whether natural characteristics, professional training, or the well-digested results of long and valuable experience, we look in vain for his superior; and those who knew him best will hesitate to acknowledge his equal."

BOOKS RECEIVED.

"THE PORTABLE ENGINE, ITS CONSTRUCTION AND MANAGEMENT."—*By William Dyson, Wansborough.* London: Crosby, Lockwood & Co.

"BULLETIN OF THE UNITED STATES GEOLOGICAL SURVEY." *Numbers 30, 31, 32 and 33.* Washington: Government Printing Office.

CATALOGUE OF THE BROWN & SHARPE MANUFACTURING CO."—January 1, 1887. Providence, R. I.: Brown & Sharpe Mfg. Co.

OBITUARY.

SIR JOSEPH WHITWORTH, the eminent English mechanical engineer, died at Monte Carlo, January 22, aged 83 years. He was born in Stockport, England, and at the age of 14 was placed in a shop belonging to his uncle. After mastering his trade he worked in various shops in Manchester and London, and in 1833 started for himself as a toolmaker in a small shop in Manchester. His business gradually increased as he gained a reputation for careful and accurate work. About 1840 he attracted attention by making, after many attempts, surface plates which were perfectly true, or so nearly so that no imperfection could be detected. This work increased his reputation, and his business increased steadily. In the London Exposition of 1851 he again attracted attention by a machine capable of measuring the millionth part of an inch, and by his standard screw threads, gauges, etc.

The improvement of cannon was then a subject of much interest, in which Sir Joseph Whitworth took part. In 1855 he patented the famous Whitworth gun, with its polygonal projectile and its construction differing from that of all rifled guns which had proceeded it, and for years much of his attention was given to this work.

Meantime his works has grown to be a very large establishment, and he turned it over to a joint stock company, in which a number of his workmen were stockholders, retaining a controlling interest for himself.

In 1868 he founded what are known as the "Whitworth scholarships in mechanical science;" they are 30 in number, of an annual value of $500 each. In 1869 he received the title of baronet.

For some 15 years past Sir Joseph spent much of his time in experimenting largely in ordnance, armor plate for vessels, etc. His experiments in casting steel under pressure are well known. Lately his health began to fail, and he was at Monte Carlo in the hope of benefiting it.

PROFESSOR EDWARD L. YOUMANS died at his residence in New York, January 18, aged 65 years. He was born at Coeymans, N. Y., and spent his early life in Saratoga; in 1851 he went to New York City, where he had lived ever since. About the same time he began to compile and write scientific books, having overcome by his own energy and ingenuity the obstacles to study presented by an illness which impaired his sight, and even rendered him totally blind for a time. By the aid of a machine which he devised, and the partial recovery of sight, he wrote the *Class-Book of Chemistry* for common schools, which was published in 1852. After this he lectured extensively and successfully before lyceums, and was perhaps the first to popularize the new doctrines of the conservation and correlation of forces, upon which he subsequently compiled a book. Mr. Youmans's interest in scientific culture, and in the diffusion of the advanced philosophical ideas of the age has had noteworthy results. He early exerted himself for the reproduction in the United States of the works of Spencer, Darwin, Mill, Bain, Huxley, Lecky, Tyndall,

Mandsley, Carpenter and other eminent thinkers. He succeeded in effecting an arrangement with the American publishers with whom he associated to pay foreign authors as American authors are paid. In 1871-72, Mr. Youmans became much interested in the question of international copyright, and went abroad to organize the *International Science Series*, on the basis of a simultaneous publication in different countries of scientific books, for which equitable payment should be made to the authors. He established the *Popular Science Monthly*, and conducted it successfully for a number of years.

GENERAL CHARLES P. STONE died of pneumonia at his house in New York, January 24, aged 62 years. He was born at Greenfield, Mass., and graduated from West Point in 1845. He was appointed to the Ordnance Department, and served until 1856, when he resigned from the army, and was for several years employed as Chief of a Commission for the survey and exploration of the Mexican State of Sonora. In 1861 he re-entered the army and served until 1864, reaching the rank of Brigadier General of Volunteers. In 1862 he was arrested and confined in Fort Lafayette under charge of corresponding with the enemy, but was subsequently acquitted by a court martial, and returned to the service.

In 1870 he accepted an offer to enter the service of the Khedive of Egypt, and was appointed Chief of the General Staff of the Egyptian Army. This position he held until 1883, and through him a number of American officers received appointments in Egypt.

In 1883 General Stone returned to the United States, and was appointed Chief Engineer of the American Committee for the erection of the Bartholdi Statue of Liberty. His last illness was very short, and his denth was unexpected.

GENERAL WILLIAM B. HAZEN, Chief Signal Officer of the United States Army, died in Washington, January 16, aged 56 years. He was born in West Hartford, Vt., and graduated from West Point in 1851. He served during the war as Colonel, Brigadier General and Major General of Volunteers. After the war he was made Colonel of the Thirty-eighth Infantry, and in 1880 was appointed Chief Signal Officer of the Army, having in that capacity control of the Weather Bureau, and became widely known throughout the country. General Hazen was a faithful and efficient officer, but his administration was much criticised, and a pugnacious disposition involved him in many controversies, and made him many enemies.

JOHN ROACH, the noted ship-builder, died at his residence in New York, on Jan. 10th. He was born in Ireland in 1813. His father failed when he was 14 years old. Soon after he came to this country, and commenced life as many other successful men have, with nothing but their own character.

The following account of his life is taken from the New York *Sun:*

Soon after coming to this country he got work at the Howell Foundry, then owned by James Allaire, and began his career in the iron business.

Three years later he found himself with a capital of $1,200. He went West with $500, leaving $700 with Mr. Allaire. Allaire failed. Mr. Roach had paid $500 on some land, the site of the present city of Peoria, Ill., and the loss of the $700 stranded him. By working on a canal he saved money enough to get back to the foundry. Three weeks later he started with some of his fellow workmen an independent foundry. It prospered, and they soon had $1,000 to their credit. His partners thought things were going at too alarming a pace, and that they should draw out while they had the wind in their favor. Mr. Roach bought them out very readily. That was some forty years ago, and in 1885 the same men were working for Mr. Roach in the Morgan Iron Works in the same capacity they occupied when they entered into the foundry enterprise.

Mr. Roach conducted the foundry independently for about six years, and then another of those disasters which seem to have dogged his footsteps persistently all through his life, came upon him and ruined him again. A heavy boiler in the works blew up, shattering everything, leveling the building to the ground and killing six men. He found a man who would lend him a little money, not all he wanted, to be sure, yet enough to warrant him in making another venture. He rebuilt his buildings and was soon at work again. From that day on his business steadily increased beyond the most sanguine hopes. It outgrew plant after plant. He bought the big Morgan Iron Works, at the foot of East Ninth street, in this city, and in 1871 he bought of Rainer & Sons, the big ship-yard at Chester, where, at one time, he gave employment to more than 3,000 men. For the Morgan Iron Works he paid $400,000.

It had been his dream to revive American ship-building, and to prove to the world that it was folly to fancy that nowhere could so good ships be built as on the Clyde. His ambition in the foundry line was pretty well satisfied. Besides the Morgan, Ætna, the Neptune and the Franklin Forge, he bought out the old Allaire Works, where he got his first job. He devoted himself almost exclusively to the Chester ship-yards. Vessel after vessel was turned out in rapid succession. Besides those from the Government he had contracts from the Pacific Mail Company, the Mallory line, the Oregon Navigation Company, the Old Dominion, and half a dozen other of the largest American lines, turning out for each first-class vessels, ranging in size from 5,000 tons down. Among them were the enormous Pacific Mail steamships *City of Tokio* and *City of Pekin*, plying between San Francisco and Japan and China. In twelve years the Chester yards turned out, completed, sixty-three vessels.

Mr. Roach was always a strong protectionist, and a believer in subsidies. He argued both in pamphlets and magazines, and orally, with a good deal of energy, that it would be impossible for an American company, even though the ships were given to it free of cost, to compete with an English line unless the Americans received a handsome subsidy.

Mr. Roach's relations with the Government, and particularly his unfortunate last contract, which resulted in the refusal, at first, of the *Dolphin*, and was followed by Mr. Roach's failure, are all fresh in the public mind. The closing of Mr. Roach's great workshops was, undoubtedly, the severest blow of his life.

Proceedings of Societies.

American Society of Civil Engineers.

A BUSINESS meeting of this Society was held in New York, Jan. 5. After business relating to the annual meeting had been disposed of, a number of written discussions of Mr. Dorsey's paper on Irrigation were read.

These discussions developed mainly the following points:

1. "Duty" (so called) of irrigation water. This is the number of acres which one cubic foot of water per second flowing through the irrigation canal will irrigate. This ranges from 56 acres on the very lavish system in vogue in Colorado, to 1,500 acres on the hose-watering system used in California for orchards. Under the latter plan, only a small space immediately around each tree is

watered. For a true irrigation system conducted economically, the duty may be set down as 150 to 200 acres, according to the amount of rainfall of the region, and assuming that the region will not produce a crop which will pay for cultivation without irrigation. Of course, where there is enough rainfall to get along with, except in very dry times, the duty will be increased over the above figures.

2. The injurious effects of irrigation on certain crops. From the California experience it is not at all clear that irrigation is advantageous for cereals in proportion to the expense of irrigating. For clover and roots of all sorts it is generally admitted to be highly profitable. For fruits of all kinds there is strong opposition to it in California. It is reported to increase the size of fruits, but to render them insipid and less able to bear transport.

3. The abrogation of riparian rights. The laws of the States and Territories where irrigation is absolutely necessary to secure crops, such as Colorado, Utah and Wyoming, have repudiated the right of the riparian proprietor to the water of streams, unless actually used by him for irrigation, viz.: An irrigation company may appropriate the entire flow of a stream not yet made use of for irrigation, but if they do not carry the whole flow, other parties may appropriate any portion of the flow which is not needed to fill the canal of the parties already in possession.

THE ANNUAL MEETING.

THE annual meeting of this Society was held in New York, January 19 and 20.

On Wednesday, January 19, the meeting was called to order at 11 o'clock, and Mr. C. E. Emery was called to the chair.

The report of the directors stated that 114 members had been added during the year, and 16 had been lost by death, transfer, etc. The number of members now is 1,019, an increase of 98. There had been an unusual activity in the Society during the year, and there were more papers contributed to the *Transactions* than in any previous year.

The Norman medal for the year was awarded to Mr. Edward Bates Dorsey, member of the Society, for his paper on English and American Railways compared.

The Rowland prize was awarded to Mr. Charles C. Schneider, member of the Society, for his paper entitled the Cantilever Bridge at Niagara Falls.

The Committee on Uniform Standard Time made an interesting report on the progress of the movement for its adoption, with particular reference to the Canadian Pacific Railway. This company has given it about a year's trial on the western division and branches, comprising altogether 2,600 miles of road. Letters were read from conductors, train dispatchers, superintendents, and the Assistant General Manager. They all spoke of its simplicity, absolute freedom from ambiguity in orders, and consequent increase of safety to passengers and traffic, of its ready adoption by the public, its great advantages in the movement of trains, etc., and they all desire its adoption over the whole line and connecting roads. It is understood that the Canadian Pacific will, within the year to come, adopt the new method over its whole line.

The Society passed resolutions recommending Mayors of cities to have clock-dials on public buildings arranged for its use, and the post-office authorities also recognize it in an official manner. The Committee was continued.

The Committee on the Form of Rails and Car Wheels presented a short report and was continued.

The Committee on Compression of Cement, Mortar, etc., under strain, made a report of progress, and referred to important information, soon to be published, which has been obtained from tests made at the Watertown Arsenal.

The place of the next convention was discussed, and the feeling strongly expressed that it was not desirable to meet in a large city. Newport, Saratoga, the Thousand Islands, Old Point Comfort, etc., were all suggested, and a resolution passed referring the matter to the Board of Direction, with the proviso that the place selected shall have a hotel large enough to accommodate all who may attend, and that it shall not be near a large city.

The result of ballot for officers was then announced as follows: President, William E. Worthen; Vice-Presidents, Thomas C. Keefer, Thomas F. Rowland; Secretary, John Bogart; Treasurer, J. J. R. Croes; Directors, William G. Hamilton, Charles C. Schneider, Stephenson Towle, James Archibald, Robert Forsyth.

After lunch in the Society's rooms, an afternoon session was held. The chief business was a discussion on the Prevention of Pipe Corrosion, in which the chief points developed were the excellent effect in this respect of riveting on pieces of zinc to the outside of wrought-iron pipes, and the fact that cast-iron pipes laid in dry sand in Philadelphia had remained for 52 years entirely free from corrosion, while the same pipe line where it passed through gravel fell to pieces shortly after being removed.

An evening session was held at 20:30 o'clock, when Mr. Charles Macdonald read the paper on a Large Testing Machine which is published elsewhere in this issue.

The reading of this paper was followed by a long and interesting discussion, in which a number of members took part. Lack of space prevents us from giving a summary of this discussion.

On Thursday, January 20, the members visited and inspected the new Suburban Rapid Transit road, and the new bridge over the Harlem River at Second avenue. They then visited the Continental Iron Works and Greenpoint, and wound up by a visit to the Statue of Liberty.

The reception at the Society's house in the evening was largely attended and much enjoyed. Supper was served at 21.30 o'clock.

New England Railroad Club.*

THE January meeting of this club was held on the evening of the 12th, with President Marden in the chair. The subject for discussion was "Heating and Lighting Cars in Passenger Service."

A number of letters were read from manufacturers and inventors of appliances for heating cars, describing the appliances which they have devised.

Mr. J. A. Coleman, of Providence, said that he believed it is just as proper to heat a train of cars from some central point, away from the cars, as it is in a house. He can see no reason why a boiler could not be placed in the baggage car and heat the passenger coaches from that. He thought some means might be devised by which main pipes might be run under the cars and so arranged as to supply heat evenly in all parts of the car. He suggested as an answer to the objection that cars cannot be heated when the locomotive is unattached, that a boiler might be located in the station so as to heat the cars by flexible connections.

President Marden said he had no doubt every railroad would like to get rid of the stoves in each car, but there are some questions he would like to have answered, and he proceeded to speak of the difficulties to be overcome where trains run out of the stations with only three or four minutes between them, and where cars are taken on or left off at branches.

Mr. J. N. Lauder, of the Old Colony Railroad, suggested that the system of heating was the one to be considered. The heating with hot water, he thought, had proved very successful, and the only possible objection he saw was the possible danger of one of the heaters breaking away from its fastenings and setting fire to the car in case of derailment. He had never heard, however, of one of these heaters ever setting fire to the cars, though he had known of their being torn from their fastenings. Still, there may be danger some time. He had thought of inclosing the heater in a compartment of boiler iron, but that derailment might take place when the doors were opened to replenish the fire. Placing the heater in the baggage car would not do away with the danger from fire, because the baggage car, in case of derailment, might be buried up beneath the passenger cars. Mr. Lauder said he believed the Old Colony has the best system of heating in the

* The most of the following report is from the *Boston Herald*.

world. He contended that, with the various stations where cars stand all night on his road, the system of heating from the locomotive is impracticable.

Mr. W. Martin, the inventor of the Martin anti-fire car-heater, said he has often heard the same objections as advanced by Mr. Lauder against heating with steam from the engine. He said the objection that steam taken from the engine would cripple it, has been proved, on the Boston & Albany Railroad, to be entirely baseless. He contended that the economy and safety to be obtained in heating from the engine are sufficient to lead every railroad to change its methods of operating its passenger service. He claimed that by his system the cars can be warmly heated in the coldest weather. When the train on the Boston & Albany road is ready to go out, the engine is attached about ten minutes before starting, and quickly heats it.

Mr. Emerson said that his system of heating cars has been in use on the Connecticut River Railroad for the past five years. He first tried a boiler in the baggage car, which was a nuisance. His method is to heat with steam taken from the engine. He then has a small boiler under each car, which is filled from the drip from the engine. This boiler can be fired up in case the engine is detached from the train. He found 1¼-inch pipe was the best size to use. At Holyoke, the railroad company had pipes arranged so that the cars could be connected with the boilers for heating the engine-house. By this means the cars could be warmed in from ten to twenty minutes, while standing at the station. The pipes in the cars are connected together by rubber hose, which cost 75 cents each and would last a few months.

Mr. G. W. Cremer said he thought it was time to have something said on the other side. They had heard of nothing but steam. He said he thought if they would place a coil of pipes in one end of the car, surround it with sheet-iron, let the cold air into the center of this coil, and then conduct this heated air along the sides of the car, they would get both the heat and the ventilation.

Mr. Chase said he had been able to heat, by exhaust-steam, a building 1,500 feet from the engine, and he, therefore, saw no reason why the longest train cannot be heated from the engine, nor why trains cannot be heated from boilers in stations before the engine is attached.

Mr. A. G. Gouge, of New York, said that some years ago, at a meeting of master car-builders, it was decided that it is necessary to admit fresh air into the car, and if so, it is necessary to heat it, and thus you get heat and ventilation both. He asked if it would not be well for the club to get up a bureau of experts who would pass upon all the several inventions.

Mr. Johnson said that he had sold about 600 of his heaters, and that it could not set fire to a car.

Mr. M. N. Forney was invited to give his views. He said he believed people are rapidly coming to the idea that the fire for heating the cars must be put outside, and if the railroads don't do it, the Legislatures will compel them to do so. The Reading Railroad has been heating a large number of its cars with heaters under the cars, and it has been doing so for ten years. He did not say there are not some objections to the system in use on the Reading, but he thought if a law should be enacted making it compulsory to put all stoves under the cars, inventors would quickly devise improvements in the various systems now in use. Mr. Forney referred to the telescoping of cars in case of collision, and explained, by drawings on the blackboard, inventions designed to prevent such accidents.

Mr. Creamer inquired if, in the recent accidents, the fires had not been caused from inferior heaters in baggage cars, and if all railroads do not put inferior heaters in their baggage cars.

Mr. Rose, President of the Main Water-Gas Company, explained the manner in which that company is heating and lighting cars.

Mr. Creamer stated that last fall the Reading Railroad bought sixty stoves to put inside their cars, and also said that two cars, heated by stoves under them, had been burned recently.

Mr. Adams said he thought the danger from a stove under the car would be as great as if it was in the car. He said his judgment is that steam is the "coming heat" for cars. He indorsed the Martin system, now being tried on the Boston & Albany.

Mr. Marden remarked that, in case of accident, he would much rather take his chances with a stove under the car body than with one inside.

Mr. Folsom thought that the stoves had been abused more than they deserve, and he did not think that it had yet been clearly established that in any of the accidents the stoves had set fire to the cars. He thought that, ordinarily, the ventilation of cars was reasonably good, that the doors are opened frequently, and there are numerous crevices that admit the air, and, speaking humorously, he said there are the two key-holes which admit some air.

Mr. Creamer and Mr. Coleman both protested, and said that the ventilation was often outrageously insufficient, to which another gentleman uttered a profound amen.

After some more desultory discussion the meeting adjourned.

At the next meeting of the Club, which will be held at the rooms in the Boston & Albany station, in Boston, on the evening of February 9, the subject of Heating and Lighting Cars will be continued.

The Master Car-Builders' Club.

THE regular monthly meeting was held at the rooms, No. 113 Liberty street, New York, on the evening of Thursday, January 20. Mr. C. E. Garey presided.

The committee appointed at the last meeting (Messrs. C. A. Smith, Willis Davis, J. T. Leighton, W. R. Davenport and C. R. Woodin) presented a brief memorial on the late Leander Garey, with resolutions, which were unanimously adopted.

The Chairman stated that the subjects for discussion were: Car Coupling, with reference to the two leading classes of couplers, the Hook and the Link and Pin types; and the value of Slack in starting trains. It was not the intention to discuss the merits of individual couplers, but those of the two leading types or classes.

Letters were read from Messrs. J. R. Kinsey, W. J. Lorraine and Peter Campbell, all referring to the advantages of a certain amount of slack in starting freight trains.

The Chairman urged the importance of the adoption of some form of automatic coupler, in view especially of the disposition to take legislative action.

Mr. Baker (Delaware, Lackawanna & Western) said that they had tried some 12 different couplers. They had found the best results with a certain amount of slack.

Mr. Thurmond said that slack could be given in a vertical plane or hook coupler, as well as with a link and pin.

The discussion was continued by Messrs. Colburn, Cook, Shinn, Opdyke and Smillie.

Mr. Hien believed that the best results, so far as starting trains is concerned, is obtained by increasing the play of the bunter springs, not by giving slack in the coupling. He also referred to the increase which had been made in weight of cars and trains without corresponding increase in strength of draw-bars, and said that the links now used in coupling were far too weak.

Mr. McKeen said that he had been promised by Superintendent Goodwin of the Lehigh Valley road opportunities for an open test of couplers on that road. Due announcement will be made as soon as the details are arranged.

A recess was then taken to enable representatives of couplers present to explain the merits of their respective devices.

After the recess the discussion was continued by Messrs. McNally, Hien, Neale and others.

The Chairman announced that the regular subject at the February meeting would be the Heating and Lighting of Passenger Cars. The question of changing the name of the Club and finding other quarters would also be brought up. The meeting then adjourned.

Contributions.

PERFORMANCE OF A PUMPING ENGINE.

BY JOHN W. HILL, M. E.

(Concluded from page 21.)

During the preliminary test of the engine, Dec. 19–21, 1885, an attempt was made to check the calculated delivery of the pumps, by an estimate of the rate of inflow to the well corresponding to the level to which the surface of the water was lowered with a given speed of the engine.

For this purpose the well was pumped down to a level, 15.18 feet below the B. M. from which the stages of water were taken during the trial for duty, the engine stopped and the well allowed to fill by infiltration to a level 6.48 feet below B. M., when it was again pumped down to 15.06 feet below B. M. and again allowed to fill by natural process to 7.25 feet below B. M.

During these tests the levels in the well were taken every 30 seconds, one observer holding the line and float and reading the levels on the line from B. M. as an index; another noting the time; and two others independently entering the time and levels in separate note-books as they were called off

It was intended, in this experiment, to pump the well down below the lowest point which would probably be reached while pumping with the engine at contract speed and this point was fixed upon the judgment of the engineer in charge of the house; but, unfortunately, upon working the engine afterwards for several hours at contract speed, the level was drawn down below the lowest in the tests for rate of inflow, and recourse was had to calculation to determine the rate of inflow at the lower levels.

The set of observations first taken of the rate of inflow to the pump well contained three known errors of time readings, which were rejected, and a curve constructed from the remaining observations was handed Prof. H. T. Eddy, of the Cincinnati University, with a request to locate the asymptotes and extend the branches of the curve, whereby rates of inflow at levels above and below those taken might be read off graphically.

In locating the asymptotes and extending the curve, Prof. Eddy had no knowledge of the probable rate of inflow to the well. but was informed that the maximum level might be found approximately 0.5 foot above the highest level read, and was limited, in developing an equation for the curve, to the 107 observations of time and line readings taken during the experiment.

The lowest point from which observations of rate of inflow were taken was 15.18 feet below B. M., while the average and nearly uniform level for 17 hours' operation of the engine, at 134.32 feet piston speed, was 16.8 feet below B. M.

From the projected curve of observation, the time required to raise the level from 17 feet below B. M. to 16.6 feet below same datum, was 0.42 minute, exhibiting a mean rate of rise of level of $\frac{0.4}{0.42} = 0.952$ foot per minute.

The well was carefully measured, and found to have a diameter of 20 feet at the coping, which was flush on the inside with the surface of the curb; and assuming (as it appeared to be) a uniform diameter for all depths, then a rate of inflow or rise of 0.952 foot per minute represented 299.08 cubic feet, or 2237.12 gallons per minute, as the delivery from surrounding soil to the well. 2237.12 gallons per minute is equivalent to an inflow of

$$2237.12 \times 1440 = 3,221,452.8$$

gallons per diem.

During the 17 hours of preliminary test, the engines worked at an average speed of 26.8647 revolutions per minute, corresponding to a displacement of plungers of

$$81.706 \times 26.8647 \times 1440 = 3,160,810$$

gallons per diem.

The mean consumption of injection water (which was drawn from the suction pipe) is estimated at 30 pounds per pound of steam condensed, and the weight of steam delivered to the condenser as 17.33 pounds per indicated horse-power per hour, as estimated from the data of subsequent duty trial.

The indicated horse-power of the engine for the 17 hours of trial, Dec. 20–21, from careful measurements of the indicator diagrams, was 80.25; and probable injection water per diem

$$80.25 \times \frac{17.33 \times 30 \times 24}{8.33} = 120,207 \text{ gallons.}$$

(Temperature of injection water, 52° F.)

The mean surface of water in pump well during the 17 hours of trial, Dec. 20–21, 1885, was 16.8 feet below B. M., and the calculated inflow 3,221,452.8 gallons per diem.

Of this quantity, it is estimated that 3,221,452.8—120,207 = 3,101,245.8 gallons were discharged through the pumps, or at this rate for the period of trial, leaving 59,564.2 gallons, or 1.89 per cent. of plunger displacement, to cover loss of action of the pumps.

Subsequent to the trial for duty, the engine was operated for test under the provision of the specification and agreement, which requires a fire pressure of 130 pounds, at 130 feet piston speed, with 70 pounds steam pressure.

To accomplish this, the high-pressure cylinder was worked at full stroke, and steam direct from the pipe was taken through an 1¼ inch bye-pass pipe into the low-pressure cylinder.

A few minutes after this test was commenced, a joint over the dome of the boiler in the old boiler-house blew out, preventing an operation of the engine for the full time desired. The pressure for fire purposes was understood to mean the total head against which the pumps work, and was measured from the surface of water in the pump well as in the duty trial.

During this test, the steam and water-pressure gauges were read independently every two minutes by two observers, and the engine counter and level of water in the pump well similarly noted, with the following results:

Average steam pressure	68.75 pounds.
" revolutions per minute	24.266
" piston speed per minute	121.111 feet.
" water-pressure gauge, "A"	115.23 pounds.
" " " " "B"	112.90 "
" " " " both	114.065 "
" level of water in pump well, below B. M	15.427 feet.
Bench mark, below water-pressure gauge	18.00 "
Difference surface of water in pump well, and cent. water-pressure gauge	33.426 "
Difference surface of water in pump well, and cent. water-pressure gauge	14.483 pounds.
Allowance for extra frictional resistance of water passages into and out of pumps	1.00 "
Total head pumped against during test for fire purposes	129.548 "

With a constant steam pressure of 70 pounds, and a

boiler capacity sufficient to furnish the required amount of steam, the engine—with the addition of the bye-pass to take steam direct into the low-pressure cylinder—will readily work against a total pressure for fire purposes of 130 pounds from surface of water in pump well, at 130 feet piston speed, or at the rate of 3,000,000 gallons per diem of 24 hours.

The indicator diagrams taken during the trial were scaled and worked with the following average results:

Diagrams from each end of each cylinder	25
Average initial pressure, high-pressure cylinder, above atmosphere	70.49 pounds.
Average cut-off in decimal of stroke, high-pressure cylinder	0.32815
" terminal pressure, high-pressure cylinder, above atmosphere	17.54 pounds.
Average counter pressure at mid-stroke, high-pressure cylinder, absolute	11.145 pounds.
Average initial pressure, low-pressure cylinder, above atmosphere	5.6125 "
Average terminal pressure, low-pressure cylinder, absolute	7.598 "
" counter " " " " "	3.29 "
Effective vacuum	11.175 "

The compound diagrams, of which engravings are presented, were worked from the diagrams taken at 1 P. M., March 9th, 1886, the originals of which are also engraved and submitted.

In the original compound diagrams, from which the engravings are reduced, the vertical scale is 16 pounds to the inch, while the horizontal scale is constructed upon the basis of 7 inches, representing the sum of the volumes of low-pressure cylinder, its clearance, and the clearance of high-pressure cylinder, which is the volume the steam occupied at the end of expansion.

The curves constructed upon all the diagrams are isothermal or Mariotte curves, which usually agree more nearly with the actual curves of expansion of first-class steam engines, than the adiabatic curve—$p \infty v^{\frac{10}{9}}$.

The indicator springs, 40 pounds for high-pressure cylinder, and 10 pounds for low-pressure cylinder, were carefully tested for pressure readings, together with the water-pressure and steam-pressure gauges. No facilities

Kalamazoo, Mich. 1:00 P.M. March 9, 1886.

H. P. Cylinder.

40 Spring.

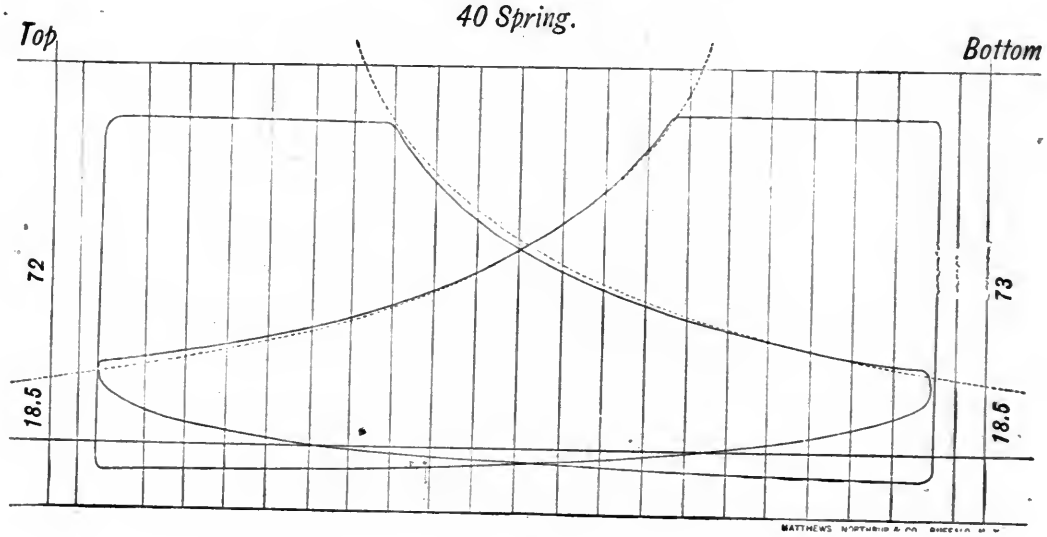


Fig. 5.

Mean effective pressure, high-pressure cylinder, top	46.668 pounds.
" " " " " " bottom	48.452 "
" " " low-pressure cylinder, top	7.583 "
" " " " " " bottom	9.164 "
Total horse-power developed	81.891
Ratio of expansion by pressure	11.18
" " " " volumes	12.03
Coal, per indicated horse-power, per hour	1.78
Steam, per indicated horse-power, per hour	17.33

Comparing the moments of load of the steam pistons and water plungers during duty trial, we have:

High-pressure cylinder, top .... 254.47 × 46.668 = 11875.6 pounds.

" " " bottom. (254.47—5.412) × 48.452 = 12067.36 "

Low-pressure " top .... 1017.9 × 7.583 = 7718.73 "

" " " bottom.. [1017.9—(2×9.28)]×9.164=9157.95 "

Average moment steam pistons,

$$\frac{11875.6 + 12067.36 + 7718.73 + 9157.95}{2} = 20409.82 \text{ pounds.}$$

The average moment of load of water plungers during duty trial was 315.1425 × 59.8384 = 18857.623 pounds, and percentage of useful effect realized in the work of the pumps:

$$100 \times \frac{18857.623}{20409.82} = 92.395,$$

leaving 7.605 per cent. of the total power of engine to cover the losses of friction.

were at hand to test the springs used on the low-pressure cylinder for vacuum readings, and it is possible, and, in fact, likely, they were somewhat in error, but not enough to affect the action of the steam, as shown by the compound diagrams.

The boiler furnishing steam to the engine is of the following dimensions:

Diameter of shell	60 inches.
Length of shell	16 feet.
Number of tubes	70
Diameter of tubes	3 inches.
Heating surface, shell	125.644
" " tubes	879.648
" " heads	16.199
Heating surface, total	1021.511 sq. ft.
Grate	4.17′ × 2.7′
Grate surface	11.3 square feet.
Tube vent	2.63 " "
Ratio heating to grate surface	90.4
Ratio grate surface to tube vent	4.296
Chimney, brick .... 3.5′ × 3.5′—	110 feet high.
Cross section of chimney	12.25 square feet.
Ratio grate surface to cross section of chimney	0.9224

During the duty trial, the coal was burned at the rate of

$$\frac{3500}{24 \times 11.3} = 11.235 \text{ pounds}$$

per hour, per square foot of grate surface.

No measurement was made of the water pumped to the boiler, because the duty terms of the specification and agreement required the economy of the engine to be calculated from the actual consumption of coal, without reference to the economy of boiler, and the work of the boiler cannot, therefore, be stated with any degree of exactness; but, as an approximation, an estimate was made of the evaporation, from the weight of steam found at release in the low-pressure cylinder, upon the assumption that 80 per cent. of the total steam would be accounted for by the indicator diagrams.

Volume of low-pressure cylinder per hour,

$$\frac{1017.9+999.34}{144} \times 2.5 \times 26.5292 \times 60 = 55743.156 \text{ cubic feet.}$$

Volume of clearance per hour; $0.025 \times 55743.156 = 1393.576$ cubic feet Weight of steam, per cubic feet, at terminal pressure in low-pressure cylinder (7.598 absolute) $= 0.0201$ pound, and weight of steam to release in low-pressure cylinder, per hour; $55743.156 + 1393.578 \times 0.0201 = 1148.448$ pounds. Less steam retained in clearance upon closure of exhaust: weight of steam at counter pressure in low-pressure cylinder (3.29 absolute) $= 0.009328$ pound.

$1393.578 \times 0.009328 = 12.999$ pounds, and steam accounted for $1148.448 - 12.999 = 1135.448$ pounds, and probable hourly evaporation by boiler,

$$\frac{1135.448}{0.8} = 1419.31 \text{ pounds.}$$

The coal was burned at the rate of $\frac{3500}{24} = 145.83$ pounds per hour, and steam, per pound of coal,

$$\frac{1419.31}{145.83} = 9.733 \text{ pounds.}$$

The setting of the boiler, and the slow rate of evaporation, would suggest a very small or no entrainment of water in the steam.

From this evaporation the "duty" of the engine was 103,000,000 foot pounds, in round numbers, corresponding to a "duty" of 105,826,000 foot pounds per hundred pounds of coal, upon an evaporation of ten to one, which is a basis of estimate for "duty" now frequently adopted in contracts for pumping engines.

Kalamazoo, Mich. 1:00 P.M. March 9, 1886.
L. P. Cylinder.
10 Spring.

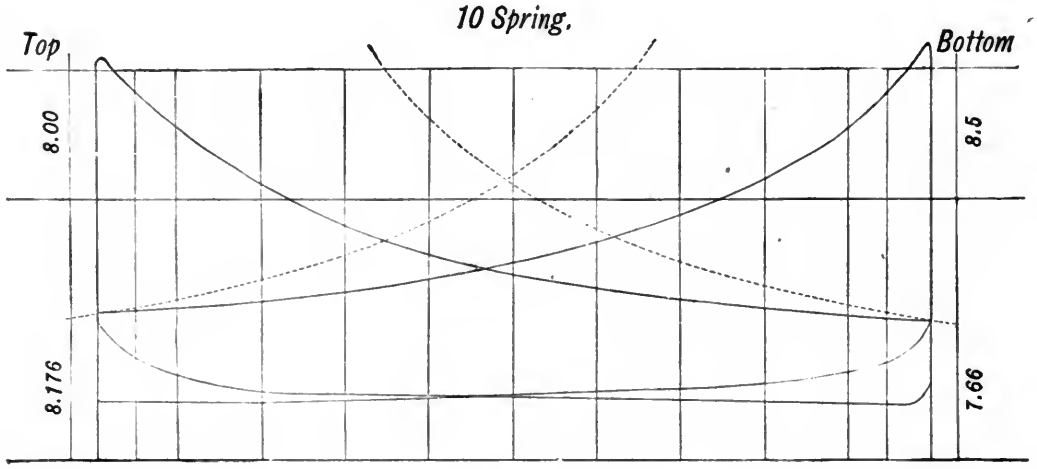


Fig. 6.

PATENTS.

BY A. K. MANSFIELD, M. E.

THE United States alone is now issuing at the rate of from 2,000 to 3,000 patents per month. This represents an outlay on the part of inventors, in fees to the government, as per the last annual report of the patent office, of about $100,000 per month. Add to this a fair average for fees paid to attorneys for the prosecution of ordinary cases, which may amount to about the same as the fee to the government, the sum becomes $200,000. The additional cost of prosecuting the more complicated cases may easily swell this figure to $300,000, which will represent the amount now being expended by inventors in the bare act of securing from the United States certified papers, with blue-ribbon attachment, which purport to grant them monopolistic privileges.

Of what value are these papers? This, of course, depends in the first place on the value of the invention in itself; but it depends, moreover, to a very important extent on whether the papers actually secure to the inventor the rights to which he is entitled.

According to the rules of the patent office, anybody may prosecute an application for a patent, either the inventor himself or whomsoever he may appoint to act as his attorney. No admission to the bar, nor course of mechanical study, nor special preparation of any kind is required by law, rule, or precedent. It follows that throughout the country men ply the avocation of "patent attorney" to the defeat of inventors. It is needless to say, there are reliable men in this calling; we are dealing at present with the evils of the system.

As a rule, the inventor of a machine knows only that he has devised a certain means which produces a certain end. To what extent the law is ready to allow him a monopoly in the field of his effort, is a matter for his "attorney" or "solicitor" to discover, with such aid or

hindrance as may be afforded by the Commissioner of Patents, or his assistants.

A great many patents are issued on inventions which are unlikely ever to be of much, if any, service to the public; but aside from this, it is safe to say, that the majority of patented inventions which may be of use to the public are covered by papers so poorly prepared that the rights of the inventor under them have very little worth. This is due to lack of skill, or to indifference, or both, on the part of "attorneys," and there can be no reasonable doubt that the possibility of such results is born of a defective system.

Most mechanical inventions have an underlying principle (that is, a principle not self-evident); if not, they would not be inventions, but mere aggregations of familiar parts not the result of inventive skill. The law is clear that a principle is not patentable; nevertheless, the law of equivalents, which secures to an inventor equivalent combination to that which he has devised, may be used to secure the monopoly to the inventor to which his discovery of a new principle entitles him. It generally requires a keen mechanical judgment to determine the principle or spirit of such an invention, and a careful analysis of the device, in the form in which it comes to the attorney, must be made, and various equivalent forms constructed in the mind in order to be able to express this principle in such language as to secure the rights to which the inventor is by law entitled. This kind of judgment is usually not possessed by an inventor, nor is it an attribute of a lawyer, nor does it come from experience in writing formal specifications. It is rather the outcome of a broad experience in and study of the science of applied mechanics. Certainly, a reasonable familiarity with legal decisions in patent causes is also an essential accomplishment.

It has come to be almost an axiomatic phrase that a patent possesses no value until it has been proven in the courts; so much so, that it has been seriously proposed that patents be always allowed when applied for, without examination into the merits of the case. This is so contrary to the apparent necessities of the system as to meet with very little approval among inventors. What we need is a more conscientious and skillful method of prosecuting applications under the present laws. How can this be arrived at? The only direct and reasonable way seems to be through the establishment of educational institutions, or through the introduction of special courses in existing institutions, which shall be designed to fit men for the specialty of patent attorneys. Laws would then need to be framed to exclude men not thus specially fitted from practicing this profession.

A dignity would thus be added to the profession, which it now lacks, and inventors would be better able to secure their legal rights without resort to expensive litigation, and would be able to obtain beneficial advice from their attorneys.

Let it be understood that these remarks do not apply to design patents, trade-marks, and the like, which are in the nature of copyrights, but to machinery patents, which constitute a large majority of all patents.

Under the system proposed, a patent attorney would be more nearly what is now known as a mechanical expert, and in place of doing the "no patent, no fee" style of business, which is often seen advertised, would be in a position to advise with his client as to the value, scope and validity of the papers which he has procured or might be able to procure.

Inventors are frequently most anxious as to whether a patent can be procured on the device which they have perhaps labored hard to produce. It is of far greater importance to know whether the patent which can be procured (for under the present system nearly anything possessing a number of parts can be patented,) will have any considerable value in the light of what has previously been done in the special art to which the invention pertains; also, to feel certain that whatever novelty exists shall be secured.

The matter of seeking for the underlying principle of an invention, and so setting it forth in the specification as to cover all equivalent methods, is of much greater importance than is usually supposed among inventors and patent solicitors.

To illustrate, an inventor applies a novel and useful device to an engine of a certain type. The device is equally applicable to engines of various other types. His attorney should have the mechanical knowledge and skill to perceive that the machine, as built by the inventor, is merely the illustration of a principle which the inventor has conceived, and should so compose the specification as to cover the combination of the device with all types of engines to which it can be usefully applied. Instead of doing this, the claim covering the device is made to read thus:

"In combination with a pair of vertical single-acting steam cylinders, a crank-shaft arranged to one side of the axial lines of such cylinders, with direct connection from each piston to the crank-shaft, substantially as set forth." If the word "vertical" had been omitted, and the words "out of intersection with" substituted for "to one side of," the point would have been covered.

Another inventor makes the application of an automatic governor to a particular type of engine, which is an original and useful application. The solicitor sees in this merely a complicated combination of parts, and expresses the invention in these terms:

"The combination, substantially as described, for actuating the auxiliary or cut-off valves G G′ by means of the governor K, it consisting in the cylindrical tube n^2 (fastened to the main valve and opening into the exhaust-chamber k' thereof by the passage o^2), the cylindrically-chambered boxes q^2 r^2 (applied to the valves G G′ by means as described), boxes w^2, the two shafts x^2, their forks y^2, and dogs z^2, the tappets d^3 (having curved arms e^3 and projections h^3), spring g^3, stops i^3, stud f^3, slide k^3 (provided with the friction-roller n^3), slotted slide p^3 (having an arm r^3), connecting-rod s^3, bell-crank t^3, arm u^3, and rod v^3, the latter being pivoted to the sliding sleeve w^3 of the governor K, and all being arranged and to operate essentially as represented."

It need hardly be pointed out that such a claim as this is of practically no value, owing to its extreme complication. It may be admitted that the law would render all liable who should make an exact copy of this machine, but no skillful mechanic would care to make such, when, as in the present case, an indefinite number of combinations can easily be made which accomplish the same result, and which the law would consider equivalents if the inventor had but made his request in proper form. The above are from actual specifications written by attorneys of note.

The law provides that the patent which an inventor accepts represents the whole breadth of his invention. How important, then, that the case shall be so prosecuted that the inventor may have the full benefit of the law.

In the process of prosecuting a patent application in this country, the inventor is plaintiff and the public defendant. The former may be represented by a solicitor, and the latter is represented by the Commissioner of Patents and his assistants. The case, on the part of the defendant, is often conducted with great skill; and at other times unnecessary obstacles are thrown in the way of the inventor, or, through an honest misunderstanding of the merits of the case, it is very difficult to obtain the rights to which the inventor is entitled. In any or all of these difficulties, the quickest and easiest method is to waive the actual merits of the case and accept the dictum of the patent office; yet a more difficult and slower course should commend itself to inventors.

Capitalists, as well as inventors themselves, are often at a loss to determine from the papers representing a patented machine whether the invention has any practical value in the light of what has been done before. A common way of determining this is by defending the patent before the courts, at great expense, if not with defeat. This may often be avoided by placing the matter in the hands of a skillful expert for investigation, before investing in the patent. A thorough study of the state of the art, as shown by the patent records, will enable him to report to what extent it advances the art to which it appertains, also whether it infringes any existing patent, as well as whether it represents the actual invention of the patentee. A full investigation of these points will often bring to light totally unexpected information, placing the value of the patent on an entirely new basis, and enabling the inventor and the capitalist to conclude understandingly whether it is desirable to "work" the patent. Such an investigation may save many dollars in costly suits at law.

It is frequently the case that a critical analysis of an invention will disclose to the eye of an expert various other methods of solving the same problem, which would not pass under the law for equivalent methods. The method developed by the inventor may indeed be the most direct, yet if capital is at stake in developing the invention, it is important to exclude competition from the particular field to which the invention appertains. This may be done, to a great extent, by having a systematic study of the field made, by one skilled in such a pursuit, for the purpose of strengthening the original patent by taking out other patents of a secondary nature. This important matter is very often neglected, a common reason being that the vanity which often accompanies the faculty of invention leads the inventor to believe that his invention is invincible. When the patent begins to realize financial success, however, to such an extent as to force itself on the attention of the public, other inventors of equal, or possibly superior, capacity are led to examine the papers and inquire into the state of the art. Then it is that the secondary patents play their part.

It is the fashion of a good many patent attorneys to end the explanation of an invention with a tedious number of claims, many of which are of no possible help to the scope or value of the patent. The claims of a patent are expressed for the purpose of making it clear to the public exactly what features of the apparatus illustrated and explained are held to be original with the inventor. These claims are of two kinds known as generic (broad, or relating to the principle or spirit of the invention), and specific (relating to the special combination of parts). Patents are not often seen with too many of the former kind of claims, for it requires skill to write them properly and exactly; but it is easy, and requires very little mental exertion, to construct combination claims embracing a multitude of parts, and the greater the number of parts the less the liability of their ever having been combined in the same manner before, and the less the liability of anybody ever desiring to combine them in the same manner again, therefore, the less they add to the value of the patent. In fact, it may be urged that a majority of the lengthy combination claims, seen in many recent patents, have a tendency to weaken the force of the patent in the courts, and it is quite certain that many of them ought to be rejected at the patent office (instead of meeting with high favor there, as they appear to) on the ground of not having required inventive skill. The writer holds that it does not follow from the fact of a patentable combination having been discovered, that the combination of this device with other well-known parts is also necessarily a patentable novelty, for such a combination as this latter may be merely the result of ordinary mechanical skill. Yet innumerable claims of exactly this nature are allowed by the office; whether justly or otherwise, it is certain that many of them do not add at all to the value of the patent. A fair illustration is the latter of the two claims quoted above.

A great army of men is at all times seeking the glory and reward of invention. There still remains endless opportunity, but, in this as in other fields, the great prizes are for the few only. Of those who fail to realize expected results, some become morbid and visionary, others continually work in impracticable fields, others make good beginnings but leave the rewards to more steadfast workers. These facts have brought the art of invention into disrepute, and all patented inventions are viewed by some people much as if they were the schemes of impracticable fanatics.

If it be considered, however, how many great mechanical industries have been built up and are now prospering, founded on the monopoly which patents grant; what a vast number of labor-saving and life-saving machines owe their existence to the exhausting toil of inventors, the conclusion must follow that one of the most valuable resources of the American nation is its unparalleled faculty of invention.

HOW TO RUN A LOCOMOTIVE.

BY RICHARD H. BUEL.

THE motor of a locomotive consists, essentially, of a pair of non-condensing steam-engines, with adjustable cut-off controlled by hand; the engines being supplied with steam from a high-pressure boiler. Steam of exceptionally high pressure is carried in locomotive boilers, for a double purpose: primarily, in order to reduce the weight of boiler and engines; and also for the purpose of producing the necessary power with a minimum consumption of coal and water.

The nearest counterpart to the locomotive, in stationary motors, is the modern non-condensing automatic cut-off steam-engine, using steam of high pressure, but with the important difference that, in the stationary motor, the governor automatically controls the speed and power of the engine; while the action of the locomotive engine is controlled by the runner, who can, at pleasure, regulate the speed and power of his engines, either by changing the point of cut-off or by admitting more or less steam to the cylinders through the throttle-valve. Now, since the stationary engine, to which reference has just been made, is commonly regarded as the most economical type of non-condensing steam engine in use at present, and the locomotive engine possesses nearly all the features of the former motor, it seems reasonable to suppose that, were the locomotive runner to control his engines as skillfully as the automatic cut-off engine is regulated by an efficient governor, the locomotive would be run in the most economical manner. It may be useful, then, to briefly consider the action of the stationary engine, and see how nearly the same action is possible for the engines of the locomotive. Generally speaking, the principal requirements for either the stationary engine or the locomotive engine are as follows: To start from rest and attain the required speed in the shortest possible time, and to maintain this speed as nearly as possible under varying loads; always producing the necessary power with the greatest economy attainable under the given circumstances.

In starting such a stationary engine as the one under consideration, the engineer opens the throttle-valve, by degrees, until the governor commences to actuate the cut-off gear, when he opens the valve wide, and leaves it in this condition until he wishes to stop the engine—unless, at any time, the load becomes so light that the speed cannot be controlled at the shortest point of cut-off, in which case it becomes necessary to partially close the valve and throttle the steam. When the engine is running, with the throttle-valve wide open, and the load is suddenly increased, the governor, if efficient, immediately adjusts the point of cut-off so as to give a longer steam-admission, and maintains the cut-off at this point until the load is diminished, when the point of cut-off is at once shortened so as to prevent an increase of speed. Such a method of running an engine seems to be very reasonable. Having generated steam of high pressure in the boiler, good sense would seem to dictate that the engine should receive the benefit of this pressure, and that it would not be very commendable practice to reduce the pressure by throttling the steam before admission to the cylinder—unless the speed of the engine could be controlled in no other way. But such throttling is only too common, in locomotive running, even by runners of great experience—with the result of an unnecessary consumption of coal and water.

Possibly, the foregoing remarks will be sufficient to convince some engineers that the most economical method of running any engine, locomotive, stationary or marine, is to admit steam of boiler-pressure to the cylinders, and control the speed by regulating the amount of steam admitted at each stroke—under the supposition, of course, that the engine is properly proportioned and adjusted for its work—but others may like to see experimental data on the subject.

Some time ago, the writer made a number of tests with locomotives, drawing light trains and stopping frequently; the tests including measurements of coal and water consumption, speed of engines, boiler pressure and power exerted, together with observations of every change in positions of link and throttle-valve. These experiments, being conducted with several locomotives, under the management of a number of experienced runners, furnish data of considerable interest in relation to handling a locomotive engine.

Fig. 1 shows two indicator diagrams from a locomotive, illustrating, graphically, two methods of running, one economical and the other wasteful. The locomotive was

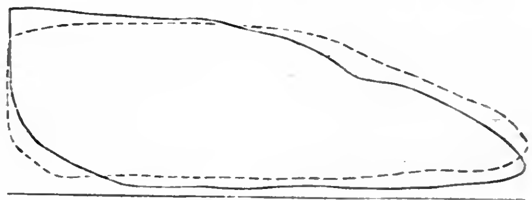


Fig. 1.

doing about the same work, in the two cases, as appears from the following data:

		Diagram in full lines.	Diagram in broken lines.
Lbs. per square inch above atmosphere.	Boiler pressure........	121	125
	Average back pressure.	7.5	13.2
	Indicated pressure.....	75	73.2
	Release pressure......	33.2	48.6
Revolutions per minute........................		190	193
Link (point of cut-off marked on quadrant)....		8	12
Position of throttle-valve......................		Fully open.	Half open.
Weight of a cubic foot of steam at release pressure, lbs....................................		0.1160	0.1504
Ratio of weights................................		1	1.3

Judging from these diagrams, the locomotive engine was using about 30 per cent. more steam in the second case than in the first, to produce about the same power. This, of course, is only an approximation, since more steam is always used by an engine than is shown by the indicator diagram; but it must be evident that the steam consumption is much less, in the case of the shorter cut-off and open throttle-valve. In the table which follows, this point is further illustrated. The results in the table are for runs of one hundred miles each, made by different locomotive runners; and in each experiment marked "preliminary," the management of the engine was left to the runner, while in the runs marked "regular," the runners were required to keep the throttle-valve fully open, except when the speed became too great, and regulate the admission by the link. In the "preliminary" runs, the steam was almost invariably throttled to some extent, and the cut-off was correspondingly lengthened—most of the runners apparently considering this method to be the best. Although a large number of experiments were made, only a few of the runs could fairly be called "preliminary," in the sense which has just been explained; because locomotive runners, as a class, are men of more than ordinary intelligence—and each runner being desirous of showing the most economical results, the old method of running was soon abandoned (during the experiments, at least) for the kind which is here classified as "regular."

The table, in addition to showing the great difference in economy between admitting steam of full pressure and throttled steam, illustrates further (by differences in results from the same locomotive on "regular" runs) the different degrees of skill displayed by runners acting as automatic governors.

ECONOMIC PERFORMANCE OF LOCOMOTIVES.

Number for reference.	Locomotive.	Boiler pressure, lbs. per sq. in. above atmos.	Lbs. of water per car-mile.	Remarks.
1	A	134	39.73	Preliminary run.
2	A	129	34.22	Regular run.
3	A	127	34.78	Do.
4	B	132	43.29	Preliminary run.
5	B	133	36.65	Regular run.
6	B	127	37.93	Do.
7	C	119	42.32	Preliminary run.
8	C	133	36.75	Regular run.
9	C	132	34.91	Do.

In one instance (experiment 7), it will be observed that the boiler pressure is much less than in the other two experiments with the same locomotive, which fact, of itself, may have a considerable effect upon the economic result. But this seems fairly chargeable to the runner, since it was easy to keep up the pressure in the other two cases, when the locomotive was run more skillfully—and it is axiomatic to say that a boiler may be large enough to supply an economical engine and may seem too small when steam is needlessly expended.

It would probably surprise any one, who had not previously investigated the subject, to see how general is the practice among locomotive runners of using throttled steam instead of steam at boiler pressure—and, of course, there must be some reason for the practice. As a matter of fact, there seem to be two prominent reasons: It requires more skill to run an engine by the link instead of by the throttle-valve; and when an engine is out of adjustment, the most economical method of running frequently becomes impossible.

If a locomotive engine is run by the throttle-valve, the runner has only to set the link so as to give sufficient admission for drawing a train over ordinary grades, and control the speed by opening or closing the throttle-valve. When he runs by the link, especially in starting the locomotive, considerable skill is required, to attain full speed in the quickest time, for the runner must move both link and throttle-valve, precisely as the stationary engineer and the governor together act in starting the automatic cut-off engine; and it requires rather more practice to vary the power by changing the position of the link, than by moving the throttle-valve lever. But our locomotive runners have sufficient skill to accomplish more difficult things than this manipulation, and the writer's experience convinces him that every runner who fairly tries the method of running by the link will scarcely go back to the more wasteful practice of running by the throttle-valve—unless the latter method becomes imperative, on account of faulty valve adjustment.

Valves out of square, that is to say, valve-motion so arranged or disarranged as to give very unequal admission at opposite ends of the locomotive cylinders, renders it necessary to run a locomotive in a wasteful manner; because the distribution of power is so unequal that a longer steam-admission must be permitted than would otherwise be the case. Hence, it becomes difficult to keep up the steam pressure, and the locomotive at once gets a bad name: the boiler will not make steam, the engine is out of line, the driving-axle boxes are badly worn, and the locomotive has all the maladies, according to the unhappy runner who finds it difficult to run on time. During the locomotive tests made by the writer, the locomotive considered to be the worst on the line was fitted up for experiment. This locomotive was the bugbear of all the runners: it wouldn't steam, they couldn't get any power out of the engine, they couldn't make time, everything was loose about the locomotive, etc., etc. After a thorough trial of the locomotive, with all its faults, the valves were squared, and no other adjustments were made. The following table shows that this simple change eradicated all the imaginary ailments:

PERFORMANCE OF LOCOMOTIVE BEFORE AND AFTER SQUARING VALVES.

Number for reference.	Steam pressure, lbs. per sq. in. above atmos.	Link (point of cut-off marked on quadrant).	Pounds of water per car-mile.	Remarks.
1	122	9–11	45.92	Valves out of square.
2	124	9–11	46.94	"
3	127	9–11	47.88	"
4	135	6–9	40.78	Valves squared.
5	133	6–9	40.03	"
6	132	6–9	39.99	"

In making very high speed with a locomotive, many runners have found by experience that it is not possible to run with the link very far down, and that the throttle-valve is only to be adjusted when the speed becomes excessive. Two diagrams from a locomotive with the

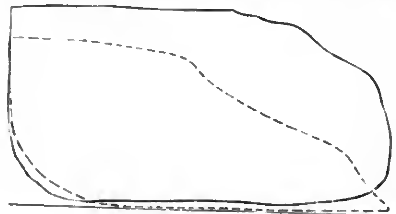


Fig. 2.

link in extreme positions, Fig. 2, show clearly that the steam can readily escape when the admission is slight, while the exhaust becomes choked and the locomotive "coughs," if the admission of steam is prolonged much beyond half-stroke. This action is not peculiar to locomotive engines. Nearly all cut-off engines have exhaust openings, sufficiently large to prevent undue back pressure, for cut-offs up to one-half or five-eighths of the stroke; but for longer admissions the openings have not enough area to permit of running the engines at full speed. Locomotive engines, and cut-off engines generally, are ordinarily proportioned so as to exert power enough for usual loads at points of cut-off not exceeding five-eighths of the stroke (and generally much less), so that, in the case of unusual loads, the engine speed is decreased. The greatest tractive force required of locomotives is in starting trains and in drawing trains over heavy grades. The diagram in full lines, Fig. 2, was taken on a steep grade, and the diagram in broken lines was taken on a level, with the throttle-valve partly closed for the purpose of reducing speed. Thus two diagrams were obtained, showing approximately the same power under very different circumstances. The principal data relating to these diagrams are as follows:

		Diagram in full lines.	Diagram in broken lines.
Lbs. per square inch above atmosphere.	Boiler pressure	125	127
	Average back pressure	7	0.5
	Indicated pressure	100.2	66.6
	Release pressure	63.6	15
Revolutions per minute		98	140
Link (point of cut-off marked on quadrant)		11	5
Position of throttle-valve		Fully open.	Half open.
Weight of a cubic foot of steam at release pressure, lbs		0.1835	0.0742
Ratio of weights		2.49	1
Indicated horse-power		124.6	118.4
Tractive force from diagrams, lbs		4,100	2,731

In starting trains, and in drawing trains over heavy

grades, the locomotive runner must handle the engine with great skill, so as to avoid slipping the driving-wheels when starting, and slipping the wheels or "stalling" on grades. The diagram in full lines, Fig. 2, represents fair practice on the particular grade where the diagram was taken—a large number of obversations made on this grade showing a minimum speed of 40 revolutions a minute and a maximum speed of 124, these two extremes being results obtained by the least skillful and the most expert runners. In drawing trains over the grade, as well as in general running, the best results were obtained by those runners whose manipulation most closely resembled the automatic action of the governor connected with the cut-off gear of a stationary engine; lengthening the point of cut-off promptly as the load increased, and raising the link as soon as the load was lessened.

The questions treated in this article are well worthy the attention of railroad officials. The experiments made by the writer show that very considerable economy in drawing trains can be effected without making any change except in manipulation, and that locomotive runners can readily be induced to exchange a wasteful for an economical mode of running. Unless there is some serious fallacy in the observations, locomotive runners might well study the action of an efficient governor on an automatic cut-off engine, and then be sent to their locomotives with the injunction: "Go ye and do likewise!"

SHOP TOOLS AND MACHINERY.

The time is long since past when the hammer, chisel and file, in the hands of a skillful and ingenious mechanic, are sufficient to produce all the different parts of machinery. Such artisans are undoubtedly an honor to their craft, and most desirable in any shop, no matter how good may be the facilities provided, but their skill alone cannot supply the lack of good tools and bring about economical production. This is so well known, and so generally conceded, that reference to it would seem unnecessary; yet a glance at the number, kind and condition of tools found in some railroad shops, cannot but impress the observer with the conviction that the advantages pointed out, are in some cases either not understood, or entirely lost sight of. That reasonable economy in doing work is attained under such unfavorable conditions, is ample proof of the ability of the managers of such shops, but how much greater would be their success if good tools and appliances were placed within their reach? Workmen will perform their duties more cheerfully if some effort is made to provide them with a shop well lighted, ventilated and heated.. The enforcement of cleanliness and order will also result in greater economy. Dingy corners will not be ornamented with piles of material, good and bad. The space under each workman's bench will not be filled with miscellaneous parts, which are stored away because they may come handy some day. This system of storage is resorted to because workmen frequently experience difficulty in procuring what they may require for a hurried job. Each of these piles is considered private property, and therefore no other workman will attempt to select from it anything he may want.

The owner alone will overhaul it each time he has occasion to look for material, and thus lose valuable time. If he fails to find what he wants he will apply to the foreman for new parts, although many, such as he wants, may be buried in other piles a few feet from his bench. The money invested in this material would in many cases go very far toward paying for the erection of a good storeroom where the necessary stock could be intelligently kept and assorted, and thus, also, save much time and therefore money by preventing delays in procuring material. The absence of a first-class tool room, and of a system requiring tools to be kept in it and issued from it, is also attended with greater extravagance and loss than is supposed by many who have had no experience in shop practices. Let the contents of each workman's drawer be examined, and in each will be found an assortment of wrenches practically alike, any of which might be used by other workmen.

Some of these may have been made for special work seldom repeated by the same man, but perhaps done occasionally by others. These are also considered private property and therefore will be duplicated some time at great cost by others, because they have no access to tools in the possession of their neighbors. The same is true of many other tools made for special work also, which will be duplicated again and again, and similarly kept out of sight by the workman, who thus practically becomes the owner. The number of cold chisels, of every conceivable shape, scrapers, files, taps, reamers etc., will be found astonishingly large and far in excess of actual requirements. The workman cannot be blamed for this extravagant accumulation. He is hired to do certain work, and if he finds that his employer shows little regard for his interest, by failing to provide a place from which he may procure the necessary tools with which to do his work promptly, and thus save him delay and annoyance, he takes the only sensible course. Cost what it may, he makes sure to provide himself with all necessary tools, and he sees that they are carefully stored and cared for until he again requires them.

We recall some incidents connected with the work of reorganizing a tool room in a shop employing a large number of men. The stock of tools was very limited and it was proposed to make necessary increases. It seemed impossible, however, that the amount of work actually turned out could have been done with the stock of tools in the tool room. The conclusion was reached that large numbers of these must be in possession of the workmen. Therefore it was deemed best to examine the contents of each drawer, and to transfer to the tool room all such as were not actually required by each workman. Drawer after drawer was inspected, and ample stock left in each, and the surplus put in a wheelbarrow, which was repeatedly emptied and refilled. Many of the last drawers examined, contained only the ordinary complement of tools, which seemed rather singular. However, nothing was said at the time, but shortly after the search was renewed, beginning with the end of the shop which on the previous occasion was examined last. The stock of tools had grown considerably in that short space of time. The surplus was again taken to the tool room, and when assorted it was found that no increase in the stock was required, but on the contrary a large excess remained, sufficient to replace similar tools, as they became worn, for quite a period of time. It was arranged to have all tools worn, or requiring dressing, taken to the tool room where others in good order were given in exchange. The worn tools were sent to the smith shop and again

returned to the tool room after being repaired, and not replaced upon the shelves until they were ground, or otherwise put in good condition. In addition to the large saving of valuable material, it was found that tools could be kept in excellent order even after one smith and his helper were removed from the tool-dresser's force.

It must be evident that the cost of a suitable tool room, and the expense of introducing and maintaining a system which would make this room a center for the manufacture, repair and custody of all tools required by the workmen, would be soon repaid by the saving in a large amount of costly material and labor entering into the manufacture of the excessive and unnecessary number of tools which are otherwise likely to be carried. The item of labor will be materially decreased if the tool work is placed in charge of expert mechanics, who can certainly produce more cheaply than other workmen who are inexperienced in this particular branch of the business. The maintenance of standard sizes and shapes, the importance of which cannot be overestimated, is possible only when this work is carried on under such a system. Interchangeability of parts of locomotives cannot be attained, unless the manufacture of templates for laying out, drilling or finishing them, is restricted to competent specialists.

To enable such workmen to accomplish these important results, machinery of the latest and most improved design should be provided. Antiquated machines are not economical and cannot produce accuracy in the manufacture or maintenance of tools.

This class of machine tools is equally out of place in other shops. Economy in production, and accuracy in finishing is impossible on many such as are so frequently found in shops. Take for instance an old planing machine, with a short table and one cutting-head. Very few pieces can be finished upon it at one operation. If four sides must be planed, four settings are necessary, involving great loss of time. On a good modern machine, with a longer table and four cutting-heads, a greater number of pieces can be finished at one time, and the number of changes to bring the surfaces to be planed to proper positions are very much reduced. We have seen locomotive frames planed on short planing machines, which made two settings necessary to plane each side, besides resetting for the top, and the bottom of pedestal legs. The work of slotting the pedestals, and other parts of the same work, is not rarely done on a single slotting machine requiring a change of position for each pedestal in order to bring it to the cutting tool. The loss of time which such tools involve is considerable. The greatest porting the portion overhanging the table, in order to care must be exercised in setting and clamping, and in supobtain any degree of accuracy in finishing these parts. This is most difficult to accomplish, since the supports often rest upon a bad and unsteady floor, which is badly shaken even by the weight or motion of a passing wheelbarrow. These difficulties would not exist if one of the modern slotting machines, with fixed table and movable heads, were used instead. Besides insuring accuracy in finishing, the cost of the work would not be one-fourth the amount that it would be if done on the other machine.

Slotting machines of insufficient stroke may be unprofitably used from day to day because only one or two pieces can be finished at one time, when a larger machine would enable twice or three times the amount of work to be done at one setting. An old lathe may often be found, used as a boring machine. Work cannot be done accurately on this except perhaps by the most expert, careful and high-priced machinist. A modern horizontal boring and drilling machine would do such work at much less cost, and with far less risk of spoiling it or of finishing it inaccurately, even when attended by an ordinary machine hand. Many parts are finished on small, antique shapers, with chisel and file, which might be finished for a trifling sum on one of the excellent milling tools now manufactured. Some boiler shops, in which new boilers are made and fire-boxes renewed, are remarkable for the absence of suitable tools. Rolls will be seen wholly unfit, either from their size or condition, to shape the sheets properly, Punches in the same condition and capable of punching only a few holes, making the drilling of many necessary.

Stay-bolts are tapped by hand at great expense, when the cost might be reduced immensely by the use of the flexible shaft, which can be obtained at a very moderate cost.

Riveting is perhaps done by hand, the cost of which might also be reduced nearly ten-fold by the use of a riveting machine. In the smith shop may perhaps be found an old steam hammer, designed years ago for work of a character totally different from present requirements. On account of limited range it cannot be used for most important work, and from old age it may be out of service, while undergoing repairs, a considerable portion of the time; the cost of which and the value of time lost on account of such delays can scarcely be calculated. A bolt-header of insufficient size and capacity may also render it necessary that many bolts of large size be made by hand, at a cost three or four times greater than they could be made for on a suitable machine. The failure to provide good forming and bending tools will also compel such work to be done by hand at great cost.

The argument may at once be advanced that such tools cost a considerable amount of money, and on that account are beyond the reach of any but wealthy companies. That is true as to the cost; but we would answer that the old machine tools increase the cost of production immensely, which cost, added to the expense of keeping them in running order, would not only pay the interest on the necessary investment for new tools, but would leave a large surplus, in addition, which would bring back a portion at least of the amount thus invested.

If the expense of equipping all the shops of a railroad company would be too great, perhaps one so equipped would be found to answer every purpose, by concentrating as much of the work as possible in that particular one. We may safely say that a careful investigation of this subject will lead to the conclusion that many tools which are tolerated in shops, would be more profitable in the scrap-heap than to retain them in service.

ALTHOUGH rear collisions have happened on the New York elevated road, crossing collisions have been exceedingly rare. The first serious one happened on January 19, when a Second avenue train struck a Third avenue train at the Chatham square crossing, badly damaging the rear car, which had, fortunately, very few passengers in it. The accident, it is stated, was due to an engineer who ran past a signal which was set against time. The number of trains at this crossing is very great, and a constant vigilance is required to prevent accident.

Selected Articles.

On the Friction of Non-Condensing Engines.*

BY R. H. THURSTON, ITHACA, N. Y.

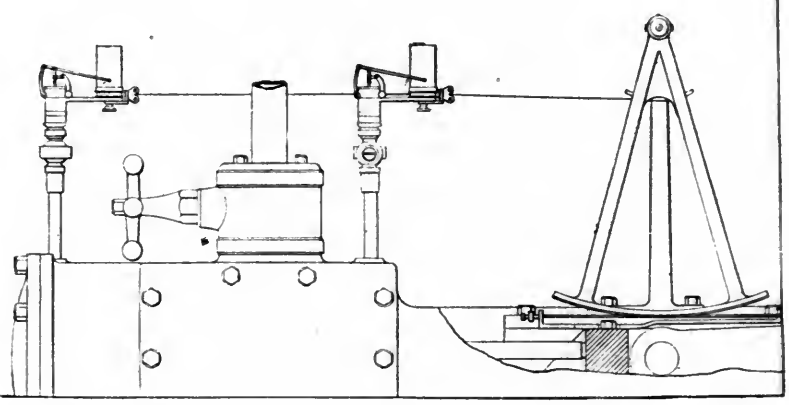
THE assumption of the distinguished engineer, De Pambour, that the wasteful resistance of a steam engine consists of a constant quantity, the friction of the unloaded engine, increased by some increasing function of the added load, has been accepted as correct by probably all recognized authorities since his time. Calling R_0 the resistance of the engine running free and under no other load than its own friction; and calling R_1 the resistance coming upon it as a useful factor of its work, and making f the co-efficient measuring the proportion of increased friction due to the load, the total resistance to be overcome by the engine piston is thus

$$R=(1+f)\ R_1+R_0. \qquad (1.)$$

but it seemed to the writer desirable that they should be checked by similar work upon another engine, if possible of a different make, before attempting to state definite conclusions of any kind. The opportunity to secure such a repetition of the investigation was offered, during the past winter, at Cornell University, using a "Straight Line" engine, which could be fitted with a brake, and conveniently submitted to test. The engine is of the same make as the first described, but of a different size, and the results of the two sets of experiments are considered to accord so thoroughly as to justify publication. The following are the data and results of these two sets of determinations:

The first of these two engines was built from designs brought out in the year 1880, of which illustrations may be seen in the *Electrician*, of December, 1883. As is well known, the engine derives its name from the fact that, in its design, the attempt has been made to take all stresses through straight members, the frame thus being made to consist of two straight compression and thrust members,

METHOD OF ATTACHING THE INDICATORS.
Fig 15.



So far as the writer has observed, it has never been questioned whether the quantity f is constant or variable, and no recent attempts have been made to ascertain its value by experiment.

It has long been the intention of the writer to settle this question, which had for years existed in his own mind, and the opportunity has recently been offered to do so, at least as that question affects the modern forms of non-condensing, high-speed engines now so generally in use, especially for electric-lighting purposes. The first investigation was made, at the suggestion of the writer and under his general direction, in the winter of 1883–4, upon a "Straight Line Engine," exhibited that year at the Annual Exhibition of the American Institute, by the Straight Line Engine Company, of Syracuse, N. Y., and built by them from the designs of Prof. John E. Sweet, the inventor of its special features.† The results were sufficiently exact and satisfactory in every respect to have been made the basis of the conclusions here to be stated;

connecting the cylinder heads directly with the main pillow-blocks, and giving a characteristic appearance to the whole machine. The valve-gear is of the "positive" type, the expansion made variable by the introduction of a governor on the main shaft actuating the eccentric in the manner familiar to all who have seen the more common forms of high-speed engines. In the design of this governor, as throughout the whole engine, special care has been taken to provide against the impeding action of friction, the machine being intended to be as nearly frictionless as possible. The engine rests upon three points of support, and thus is not liable to be thrown out of line by any inequalities of foundation or bolting. When tested, the engine to be experimented with was simply set on blocking, and had no foundation; but so well was it balanced, and so perfectly was its alignment maintained, that it ran with absolute smoothness, and as steadily as if it had been given the heaviest foundation possible.

For the purposes of test, it was fitted with a pair of carefully standardized indicators and a Prony brake. Cards were taken simultaneously from both ends of the cylinder,

* Paper read at the meeting of the American Society of Mechanical Engineers, held in New York.

† The work was done with equal care and skill by Messrs. Mitchell and Aldrich, graduates of Stevens Institute of Technology, of the class of 1884.

and, at the same instant, readings from the brake were obtained. A comparison of the power indicated by the diagrams and that shown by the brake gave a difference which measured the friction of the engine. During the trial, the engine, when working at its rated power, consumed, according to the indications of the diagrams, 28.2 pounds of steam per horse-power per hour, or, probably, between 35 and 38 pounds, allowing for the loss by cylinder condensation, not accounted for on the indicator card, a very excellent performance for an engine of but 35 horse-power. The action of the governor was extraordinarily perfect. The engine was adjusted to make 230 revolutions per minute under 90 pounds steam pressure. The observers reported that it made the same number of turns whether loaded or unloaded, an evident impossibility with a governor of this class, in which only approximate isochronism can be attained. The writer, to settle the question, counted the revolutions, minute by minute, with a hand-speed counter, and made it 230 revolutions with the whole rated load on the engine (35 to 40 horse-power), and 231 when entirely unloaded, the brake-strap being loosened until it could be shaken about on the pulley, by the hand, with perfect ease. This was repeated until no question could longer exist in regard to the matter. The variation with variable steam pressure was greater.

The following are the data obtained from the brake and indicator readings :

Number of Card.	Revolut'ns.	Steam Pressure.	Brake H. P.	Indicator H. P.	Diff.	Friction per cent.
1	232	50	4.06	7.41	3.35	45
2	229	65	4.98	7.58	2.60	34
3	230	63	6.00	10.00	4.00	40
4	230	69	7.00	10.27	3.29	32
5	230	73	8.10	11.75	3.65	32
6	230	77	9.00	12.70	3.70	29
7	230	75	10.00	14.02	4.02	28
8	230	80	11.00	14.78	5.78	25.5
9	230	80	12.00	15.17	3.17	21
10	230	85	13.00	15.96	2.96	18.5
11	230	75	14.00	16.86	2.86	17
12	230	70	15.00	17.80	2.80	15.75
13	231	72	20.1	22.07	2.06	9
14	230	75	25.00	28.31	3.36	11.75
15	229	60	29.55	33.04	3.16	9.5
16	229	58	34.86	37.20	2.34	6.3
17	229	70	39.85	43.04	3.19	7.4
18	230	85	45.00	47.79	2.75	5.8
19	230	90	50.00	52.60	2.60	4.9
20	230	85	55.00	57.54	2.54	4.4

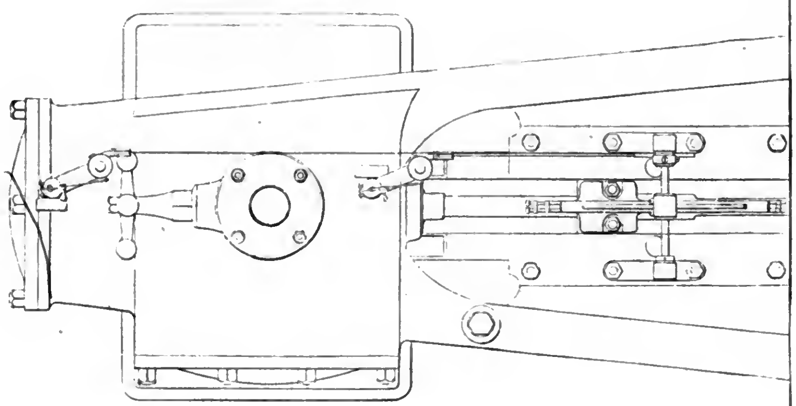
This engine was 8 inches in diameter of cylinder, 14 inches stroke of piston, having a rod 44 inches long between centers, a balanced valve with stroke of 2 to 4 inches, according to position of governor and eccentric, a fly-wheel 50 inches in diameter, weighing 2,300 pounds, the steam and exhaust-pipes having diameters of 2½ and 4 inches, respectively, and the whole machine weighing 2½ tons. The space occupied by the engine was 9 feet 4 inches in length, by 4 feet 8 inches in width, and 3 feet 10 inches in height.

Examining the above table of powers, it is seen that the difference between indicated and dynamometric power, the friction of the engine, varies somewhat, with varying steam pressures and varying total power; but in such manner as to indicate the controlling cause to be irregular in action, and possibly to some extent due to errors of observation and to accident. The maximum is four horse-power, the minimum about two horse-power. The usual difference is about three and the variations are irregularly distributed throughout the whole range of experiments. It is evident at a glance that the law of De Pambour does not hold, and that it is as nearly correct to say that the friction of engine is constant as otherwise. The column of friction, as given in percentages of the total power, exhibits the same fact. There is continual, though somewhat irregular, reduction of the percentage of friction, throughout the range from the lowest to the highest power, and very nearly inversely as the power exerted. This is best shown by the curve given in the accompanying plate (Fig. 23), in which a smooth line has been drawn to represent as nearly as possible the mean of all observations. It is evidently more nearly correct to assert that the friction of a non-condensing engine of this class is constant, and independent of the total power developed, than to accept the rule of De Pambour. The power for which the engine is proportioned is 35 to 40 horse-power. At this power, the friction of engine is but about 6 per cent. of the total, or less than one-half that assumed by De Pambour, and accepted as correct by Rankine, for engines generally, and presumably for locomotives especially. The result is exceedingly gratifying, and seems to the writer extraordinary for so small an engine.

The repetition of the experiment upon an engine of another make, having a cylinder 9 inches in diameter and a stroke of piston of 12 inches, which would naturally give

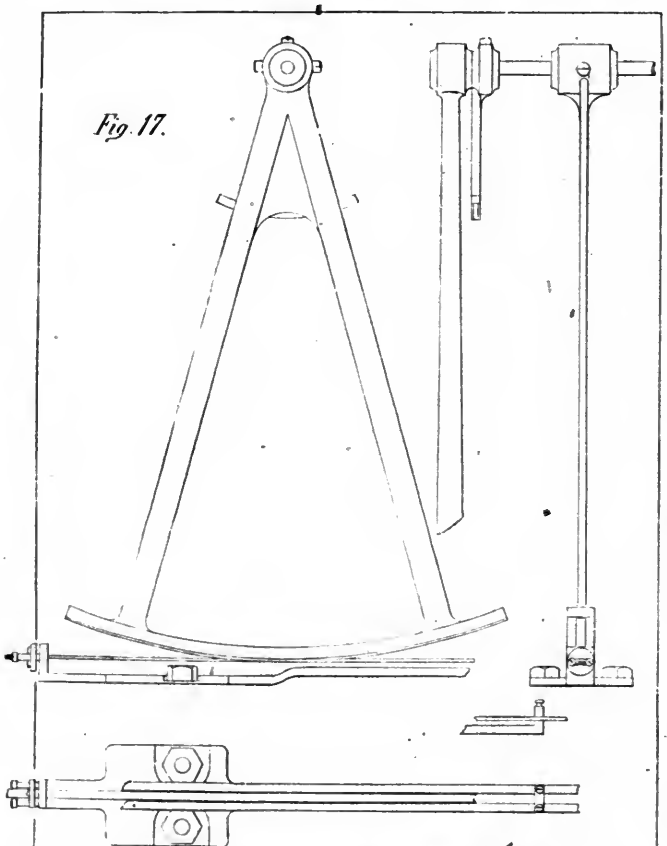
METHOD OF ATTACHING THE INDICATORS.

Fig 16



a somewhat increased percentage of friction, in consequence of the proportionally smaller stroke, at 20, 30, 50 and 65 horse-power, by brake, and running free, revolutions 300 per minute—a speed which may also have caused some increase in frictional resistance, not only in rubbing parts, but by increasing back pressure—gave a friction of engine measuring from 2.66 horse-power unloaded, to 4 horse-power at 20 to 30 horse-power, 4.8 horse-power at 50, and 5.3 at 65 horse-power, the total friction increasing perceptibly, as assumed by De Pambour, but decreasing in percentage of load, from 16 to 7.5, between 20 and 65 horse-power. It is very nearly constant throughout the whole range of power that the engine would be worked under ordinary circumstances, and may be so taken without serious error; while the adoption of the De Pambour formula would give a value of *f* so small that its use would not be attended, ordinarily, with sufficient increased exactness to compensate for the additional trouble in-

Fig. 17.



DETAILS OF REDUCING MECHANISM.

volved in its application. At their rated powers the two engines thus exhibit efficiencies of mechanism of about 94 and 90 per cent., respectively.

The second series of experiments were made * during the latter part of last college year, confirming the deductions already given, while some very interesting and original modifications were made in the details of method and trial. The engine taken for test was a machine recently built and sent to the Cornell University for purposes of experimental investigation in electrical measurement and other work of the college. It is an engine 7 inches in diameter of cylinder and 12 inches stroke, or more exactly, 6⅞ inches in diameter; the cylinder having been bored slightly under size. The general plan of the engine is similar to the first of those already described, and, like that, is carefully designed with a view to reducing friction to a minimum, and giving a regulation of maximum efficiency. The brake was precisely like that used in the first described experiments, and was built for the engine constructed in the college workshops, under the direction of the inventor, and exhibited at the Centennial Exhibition in 1876. It was constructed by the Straight Line Engine Company and adapted, with very little alteration, to the new engine. The indicators were carefully standardized and put in good order in every respect, by the makers, for the purposes of these investigations. The reducing mechanism used in connecting the indicator barrel to the cross-head of the engine was designed and built by the observers, and fitted with a very firm connecting arrangement, and with an ingenious detaching device. A sector was constructed which was pivoted above the cross-head, and hung in the vertical plane above the latter, the engine being horizontal. The arc of the sector carried a pair of steel ribbons, one attached to each end, each carried around the arc and secured, at its opposite end, to the end of a bar fastened on the cross-head, in such manner that the two ends of the ribbons at the cross-head bar being well secured and tightly drawn up, by means of screws placed conveniently for the purpose, all back-lash was prevented, and an absolutely exact synchronism of movement of indicator line and cross-head was obtained. The engine was driven at 285 revolutions per minute, and it was, therefore, very important that this rigidity of connection should be secured. A smaller sector at the upper part of the larger one was the carrier of the cord, and the combination was thus a perfect means of reproducing the motion of the engine on the smaller scale required in working the paper-barrel of the indicator. The "cord" was piano wire, a material much less liable to cause difficulty by stretching than any other that was available. Its free part was kept taut by a "spiral" (helical) spring, attached beyond the point of connection with the paper cylinder.

In the first of these experiments, as already described, Thompson indicators were used; in those about to be considered, Crosby instruments. It was hoped that the new Tabor indicator could be used also, but none were received in time. The instruments used worked perfectly, and gave no trouble from beginning to end. The speed indicators were of several kinds. Hand instruments of two or three kinds were used to check the records of the automatic instruments. A "tachometer" was attached and belted to the engine-shaft, and afforded a very convenient means of watching the momentary fluctuations due to variations of load, of steam pressure, and of accidental disturbances. A chronograph was also attached, connected with the standard clock in the physical laboratory, to beat seconds. A commutator was placed on the engine-shaft, making contact at each revolution, and a key near the engine, for the purpose of breaking contact. A Brown mercury speed-indicator served excellently well for a constant speed-indicator. It exhibited instantly any variation of speed from the normal. The chronograph was set in operation when the indicator cards were taken, and thus gave the exact speed of the engine at that instant. Great care was taken to keep the instruments, and the engine as well, in good order and well lubricated throughout the series of experiments. Some stiffness of the governor, however, the cause of which was not dis-

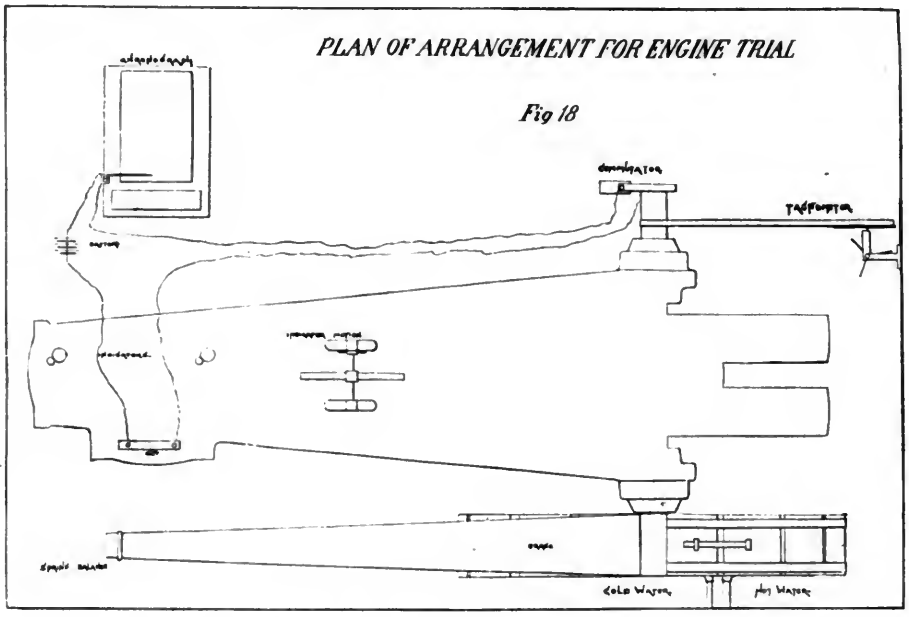
* By Messrs. W. A. Day and W. H. Riley, at Cornell University.

covered until after the work had been completed, caused it to work less perfectly than in the engine first used, and the speed varied more than in that series of determinations. When the governor was in its most perfect adjustment, the engine was capable of holding the standard speed within a fraction of one revolution throughout a wide range of work, and nearly down to the lowest power that such an engine is at all likely ever to be called upon to supply.

The mean effective pressure required to drive the engine alone, loaded and unloaded, throughout the whole range of the trials here made, was 4.55 pounds per inch of piston, and was nearly constant, as in the first investigation. The steam pressure usually ranged between 65 and 75 pounds per square inch at the steam-chest, but, when it was desired to secure a card to be more easily worked up, the pressure was dropped to 20 pounds. A series of special experiments made to determine the question whether the friction of engine is variable with boiler-pressure, although

stant speed, is practically constant at all loads and that the differences and irregularities observed are due to accidental causes. The variation of speed recorded here is in some cases due to differences of steam pressure, partly purposely produced, and partly coming of the fact that it was necessary to take steam as it could be obtained, and was impracticable to secure steady pressure, and in other instances was due to the fact, afterward discovered, that the governor had been adjusted in such manner as to be slightly cramped, and thus deprived of its wonderful sensitiveness and accuracy, as exhibited before this defect had been introduced, and after it had been remedied. Chronograph records, made later by Prof. Anthony, exhibit the most extraordinary smoothness.

These variations of speed served the useful purpose of calling attention to the fact that the engine-friction varied, at constant load and speed, with variation of steam pressure, and to a very noticeable amount, within the usual range of pressures met with in practice. It is seen that



PLAN OF ARRANGEMENT FOR ENGINE TRIAL

Fig 18

not in all respects satisfactory, indicated a slight increase in engine friction as steam pressures rose. The conclusion already arrived at by the writer, as deduced from the work previously done, that the engine friction, in this class of steam-engine, is constant, or sensibly so, under all loads, is thus here again confirmed. The following are the data obtained, arranged as before, to exhibit the relation of the indicated to the dynamometric powers:

1. No. of Card.	2. Rev. per Minute.	3. Steam Press.	4. Brake Power. H. P.	5. Ind. H. PPI. per card.	6. Diff. Frict. H. P.	7. Mean F. Press.	8. Friction per cent.
1	282	19	0	2.26	2.26	3.70	100
2	288	65	4.87	8.43	3.56	5.56	42
3	286	66	7.61	10.95	3.33	5.25	30
4	284	65	10.30	12.93	2.89	4.13	20
5	285	71	13.10	15.99	2.61	4.25	18
6	284	76	15.80	18.79	2.99	4.71	16
7	284	74	18.55	20.73	2.65	4.18	12
8	280	67	21.00	23.73	2.73	4.37	11
9	279	65	23.61	25.95	2.33	3.73	9
10	280	75	26.39	29.95	2.36	5.38	11
11	280	72	29.03	32.22	3.19	5.15	10

The first glance at column 6 or at column 7 of the above table, in which the horse-power absorbed by the friction of the engine, and the mean effective pressure corresponding to that power are presented, shows that, as already concluded, the resistance of this class of engine at constant speed, is practically constant at all loads and that

in rising from 19 to 76 pounds steam pressure, the pressure demanded to give the engine its normal speed, unloaded, ranged from below 4 to above 5 pounds per square inch of area of piston, the pressure required in the cylinder rising, on the whole, though irregularly, as steam pressure rose. In order to determine whether this, which might prove to be a hitherto unobserved law, were true, the following data were obtained by a series of experiments made for the purpose of settling this new question:

No. of Card.	Rev.	Steam Press.	I.H.P.	Mean Press.	Mean F. Press.	Per ct. Frict.	
1	250	25	6.01	10.84	1.95	18	Ten pounds on the brake.
2	271	39	6.52	10.85	2.71	27	
3	285	42	7.17	11.35	3.63	32	
4	280	46	7.08	11.60	3.59	31	
5	271	58	6.81	11.28	3.16	28	
6	289	63	7.85	12.25	4.65	38	
7	286	68	7.77	12.25	4.90	40	
8	283	77	7.88	12.47	3.74	38	
9	296	82	7.87	12.00	4.68	39	
10	275	71	2.10	3.46	3.46	100	No load on the brakes.
11	279	66½	1.995	3.22	3.22	"	
12	277	44	1.708	2.78	2.78	"	
13	275	35	1.71	2.80	2.80	"	
14	275	30	1.613	2.64	2.64	"	
15	272	25	1.876	3.11	3.11	"	
16	270	19	1.724	2.88	2.88	"	
17	270	15	1.712	2.86	2.86	"	

In the first set of experiments, here numbered 1 to 9, inclusive, the weight on the brake-arm was kept constant at ten pounds; in the remaining experiments all weight was removed. In both sets, the same general effect is seen. As the steam pressure rises, the speed being the same and the resistance the same, the friction of the engine increases; from 2 pounds, at 25 pounds pressure in the steam-chest, to nearly 5 pounds per square inch of piston at the maximum, 82 pounds steam in the valve-chest. As the steam pressure fell from this point to 15 pounds, in experiments 9 to 17, the load being thrown off entirely, and the speed being nearly constant, the mean pressure measuring the friction of engine falls again below 3 pounds per square inch of piston. The difference is considerably less in the last series than in the first; which apparent discrepancy is accounted for by the fact that the variation of steam pressure in the first series was accompanied by a greater change of speed of engine than in the second. The resistance is seen to increase slowly, therefore, with increase in speed of rotation. The effect of change of pressure is, in these cases, more marked than that of alteration of velocity of the engine.

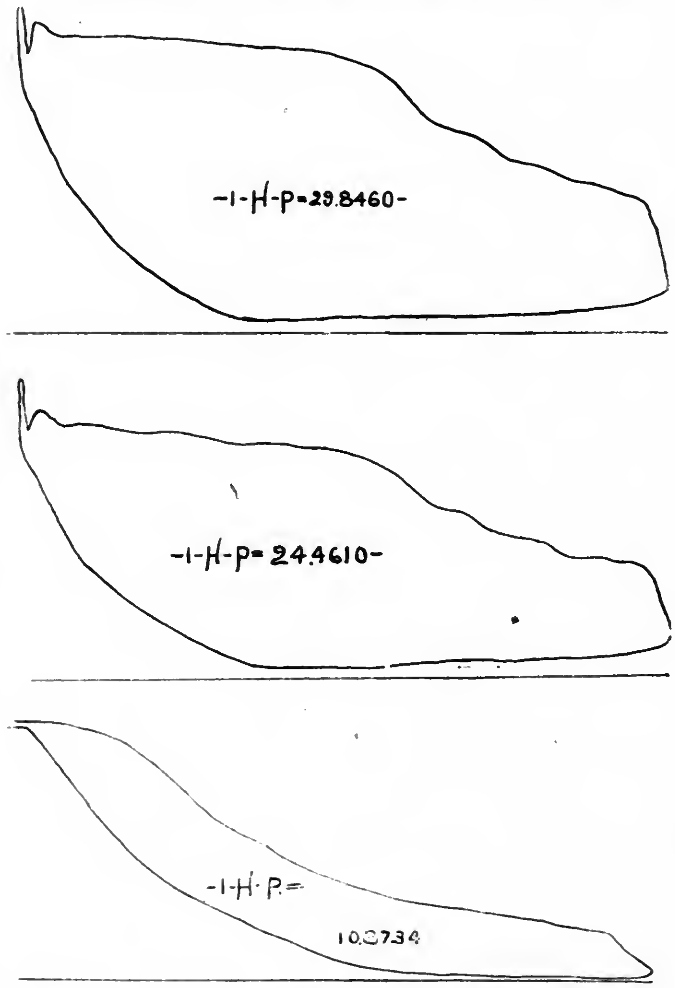


Fig. 19.

The accompanying illustrations show the apparatus and exhibit the facts revealed by the investigations, which have now been described, better than can the text. Fig. 15 shows the method of attaching the indicators, with an elevation of the engine cylinder and section at the cross-head; Fig. 16 exhibits the same arrangement in plan; Fig. 17 gives an enlarged view of the reducing mechanism and attachment to the cross-head; Fig. 18 is an outline plan of engine and surroundings, exhibiting the location of instruments; and Figs. 19 and 20 represent characteristic diagrams obtained by means of the indicator, showing the variations of steam distribution with variations of load on the brake. All these illustrations refer to the work of later date. Figs. 21 and 22 are given to exhibit the method of variation of mean friction pressures with variation of load, the variation of the percentage of friction resistance as a fraction of total resistance with varying loads, for the last investigation; and, for comparison the same ratios, as obtained in the work done at the American Institute Exhibition, are given in Fig. 23. These last curves are seen to be approximately hyperbolic; while the first given is a straight line. The originals of these curves were carefully plotted by Messrs. Day and Riley, from the records of original observations, and beautifully represent the laws which it was the object of these investigations to reveal and establish.

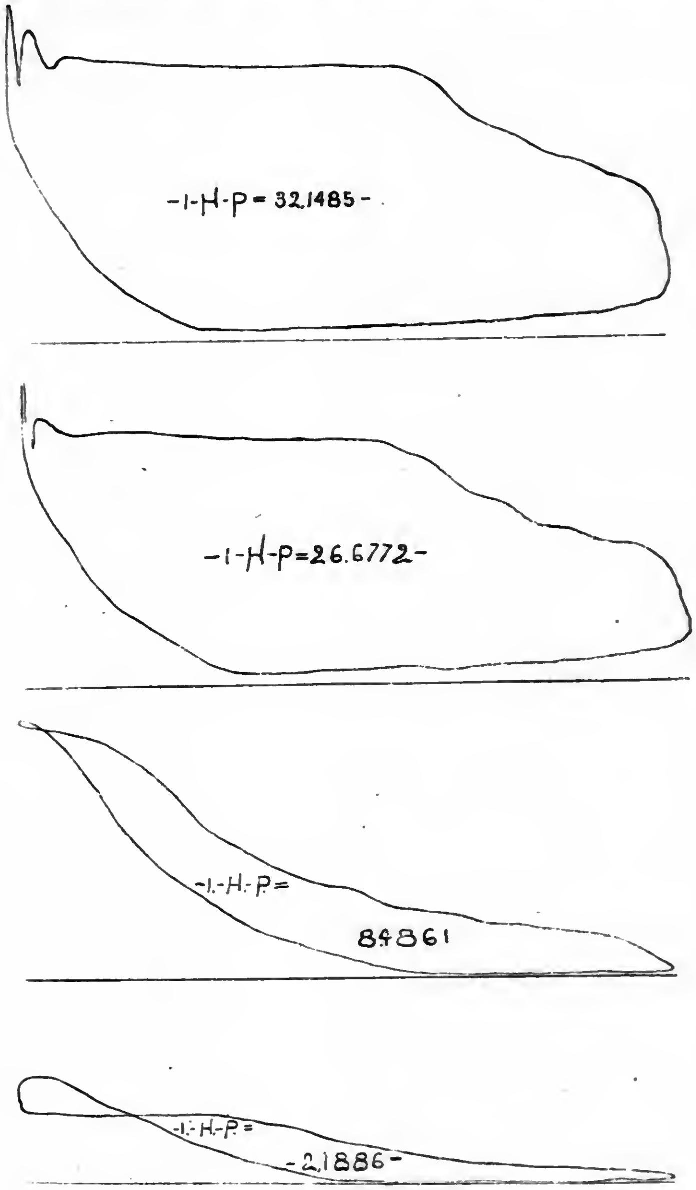


Fig. 20.

After a survey of this work, it may be asked, How does it happen that rise in steam pressure produces evident increase of the frictional resistance of the engine? It was long ago shown by the writer, and is now well established by many independent investigations, that, with good lubrication, increase of pressure on a journal gives de-

creased co-efficients of friction, and this would seem to show that the friction of engines in which the resistance caused by friction is mainly due to journals and lubricated surfaces, should become less as pressures increase, the useful load and the speed of engine remaining constant. This query is a very natural one, and is based upon a correct statement of fact, however inconsistent it may seem to be with the results above derived. The cause of the apparent discrepancy is attributable, probably, to the variation produced by the action of the governor in the distribution of steam. It will be seen that the effect of increase of steam pressure is to cause acceleration of speed of engine, a change essential to produce the action of the governor at all, and that it results in the readjustment of the set of the valve in such manner as to cause the greater proportion of the nearly constant amount of work performed to be done more nearly at the commencement of the stroke, at a point in the orbit of the crank-pin at which the work is mainly lost by friction, and to reduce the proportion of total work done at or near the "half-center," where it is principally useful. The proportion of useful to lost work is thus varied in such manner as to give a mean final result which is the less favorable as the steam pressure is higher, and the cut-off shorter, giving a higher ratio of expansion. It is also evident that, if this explanation is correct, the difference here noted will be less as the point of cut-off approaches and passes the half-stroke position of piston and cross-head. Could the valve be set with negative lead for all positions at the point of cut-off, as is considered right by some experienced engineers, the work would be more nearly performed at positions removed from the "dead points," and the variation here described would be thus reduced, while the efficiency of the engine would be increased.

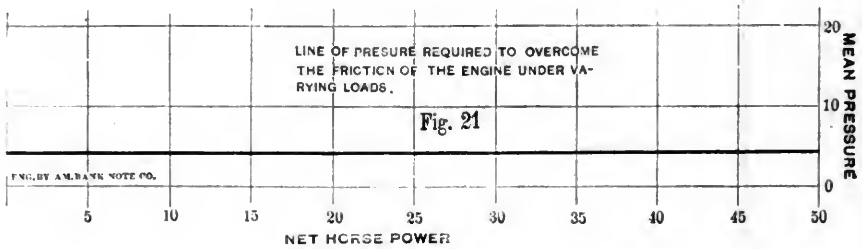
Prof. Rankine proposed the formula:

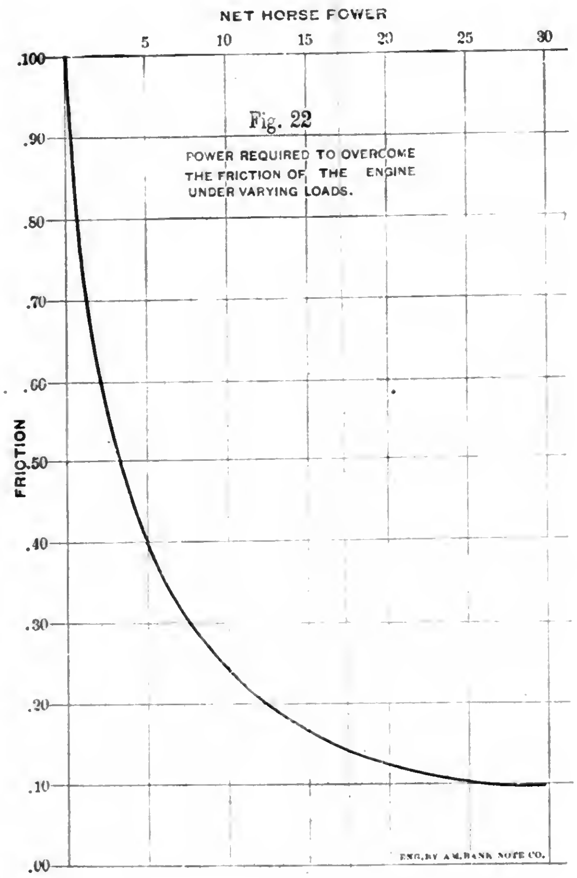
$$R = R_1 (1 - f) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2.)$$

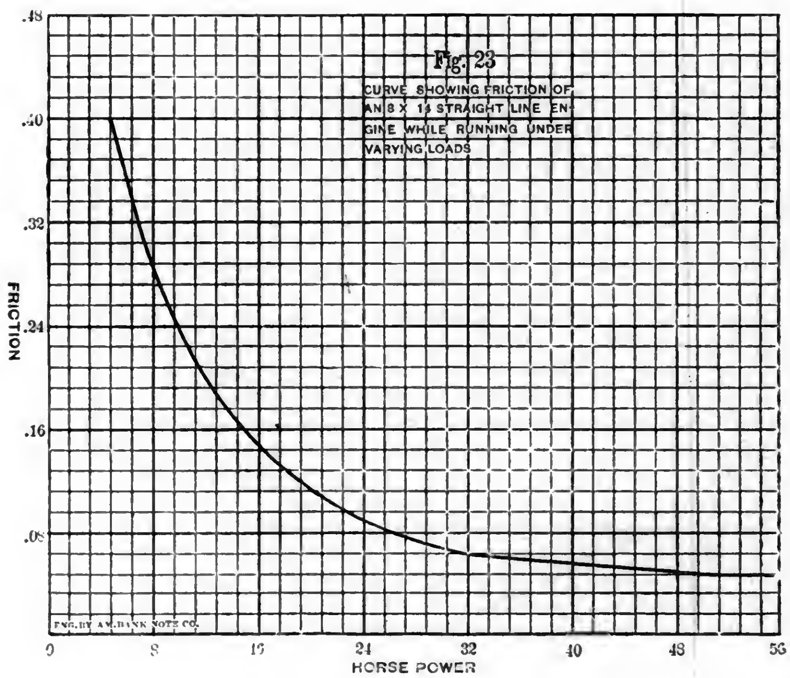
This formula is evidently inadmissible, at least for the class of engine which was made the subject of the experiments which have been here described. Since the friction of engine is, so far as can be here seen, sensibly independent of the magnitude of the load and of the resistance produced by it, the correct formula would seem to be:

$$R = R_1 + R_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3.)$$

the total resistance met at the piston being the sum of the resistance of the engine itself and that of the load, both being determinable, both being independent, and being governed by entirely different laws.







The conclusions to be drawn from what has preceded are obviously the following:

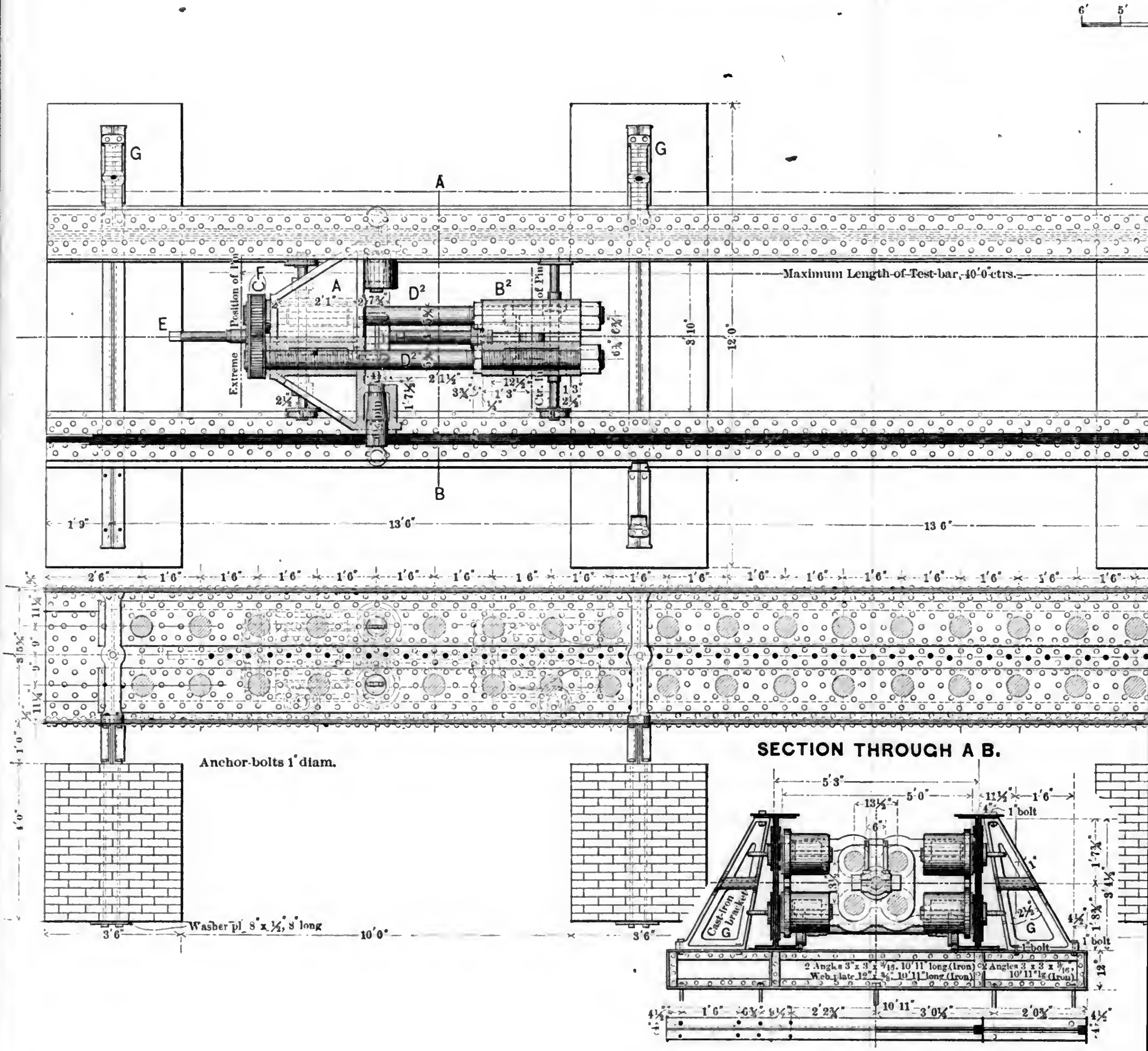
(1.) The friction of the non-condensing engine, of the class here described, is sensibly constant at any given speed, at all loads, and is, at different speeds, entirely independent of the magnitude of the load.

(2.) The friction of engines, of the type described, is variable with variation of speed of engine, increasing as speed increases, in some ratio as yet undetermined, but probably different with every engine, and, for the same engine, with every change of conditions of operation.

(3.) The friction of engines increases with increase of steam pressure, in the case of the class here referred to, in a probably similarly variable manner with that observed

GENERAL PLAN OF 1,20

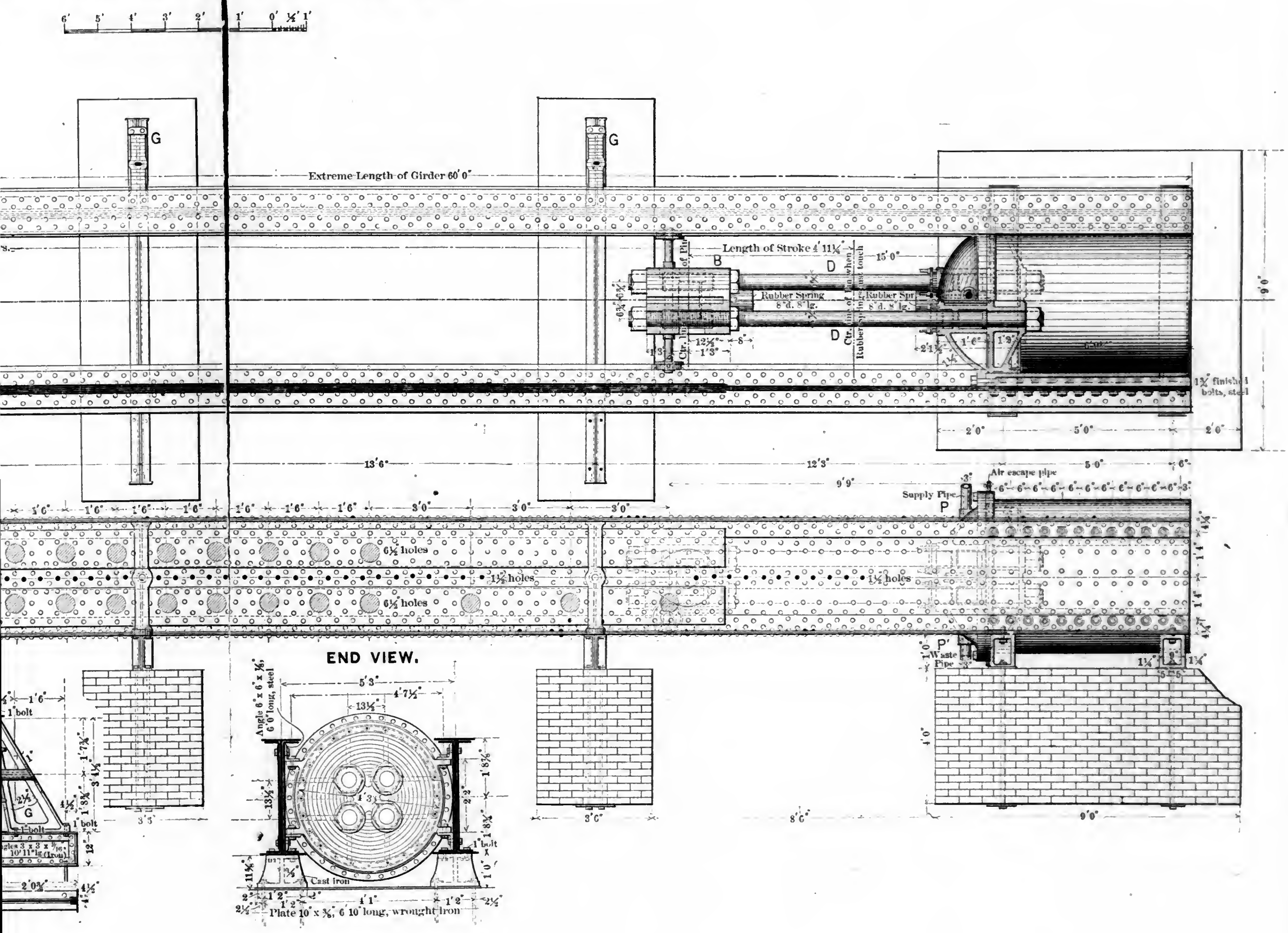
MAXIMUM WATER-PRES



OF 1,200,000 LBS. TESTING MACHINE.

WATER-PRESSURE 600 LBS. PER SQUARE INCH.

Plate I.



with alteration of speed, neither method of variation being capable of representation by any convenient algebraic expression.

(4.) The total resistance measured at the piston of the engine is composed of two parts, the one sensibly constant at the working speed, the other variable with external load, and may be, for practical purposes, at least, represented by the expression:

$$R = R_1 - R_0,$$

in which R is the total resistance, as shown on the indicator diagram R_1, the resistance due to the external load; *e. g.*, as measured by a Prony brake, and R_0 the resistance of the unloaded engine, as shown by a "friction card" taken with the steam-engine indicator.

It is sufficiently obvious that these conclusions are, at present at least, only certainly applicable to one class of engine. It is not improbable that the condensing engine may be subject to quite different laws. It is to be hoped that this question may be settled by direct experiment at an early day. The custom has obtained, hitherto, of allowing a certain pressure per square inch of piston as the equivalent of the friction resistance of the engine in marine practice—this pressure being taken at from 2½ pounds in the case of engines of moderate size, to 1½ with the largest engines. It has never yet been ascertained whether, or to what extent, the friction of engine is augmented by the imposition of load. The assumed figure represents from 5 to 10 per cent., usually, of the total indicated power of the engine. Isherwood has taken 7½ per cent. of the useful load as the amount of increase of friction of engine due to its action. This estimate is stated to be made on the basis of the data given by General Morin, whose co-efficients for friction of lubricated surfaces are now known to be enormously larger than those customarily met with in practice in well lubricated journals of large size working under heavy pressures. In such cases, when the surfaces are in good order, the co-efficient is known to fall to below 1 per cent., instead of being from 3 to 5, as given by Morin, as determined under the different conditions of his experiments. Where the journals are not well lubricated, and especially when they are rough or cut by abrasion, friction may increase enormously and may pass far beyond the figures given by Morin even; but such exceptional conditions cannot be taken into account to establish laws for application in design, or in good practice. For all cases in which the friction varies, as in the examples here above illustrated, the "friction card" sensibly represents the correct tare, whether the engine be loaded or unloaded.

A word in explanation of the fact here shown that the increased load thrown upon the shaft, crank-pin, and cross-head journals does not noticeably increase the friction of engine, will be considered not out of place here. The friction of engine consists of the resistances due to the motion of the various piston, valve, and other rods through stuffing-boxes and in guides, the friction of the piston rings on the cylinder surface, the friction of eccentrics, and, often, other parts which are independent of the magnitude of the load thrown upon the engine by the useful resistance, in addition to the friction of the journals transmitting the effort of the steam to the exterior resisting work, and of the cross-head guides and other parts indirectly affected by its variation. It thus happens that the resistance due to the friction of the latter may be, and often is, but a small proportion of the whole friction of engine. The total friction of engine, as has been seen, in engines of the class here studied, and of the sizes described, amounts to about 10 per cent. of the total power developed when fully loaded; but the co-efficient of friction of any one journal, if well lubricated, has been found by the writer, by hundreds of experiments, under such pressures as are usual on the main journals of the steam engine, to fall below 1 per cent., and the absorption of work and energy is thus a still lower proportion of the work of the steam in proportion as the speed of rubbing is less than that of the piston. The loss of power along the line of connection is thus exceedingly small. It should never exceed probably 2 per cent. of the work done, or between 10 and 20 per cent. of the total friction. Again, the co-efficient of friction, within the usual range of pressures on these journals and the guides, with good lubrication, increases rapidly as pressures fall, and decreases as greatly when the pressures increase with variation of engine power and load, and this often occurs so rapidly that the total frictional resistance, on these parts, even, varies very slowly with variation of load; while the friction of the other portions of the engine, above mentioned, remains quite constant. The resultant effect is, as shown by the investigation here described, a practically constant friction of engine under all loads, the speed and steam pressure being constant. Whether this is true of condensing engines is doubtful, and it would be an important extension of this research, could similar investigations be made of the friction of other forms, and especially the marine steam-engine and pumping engines.

The Six-Hundred Ton Testing Machine at the Works of the Union Bridge Company, at Athens, Pa.*

BY CHARLES MACDONALD, M. AM. SOC. C. E.

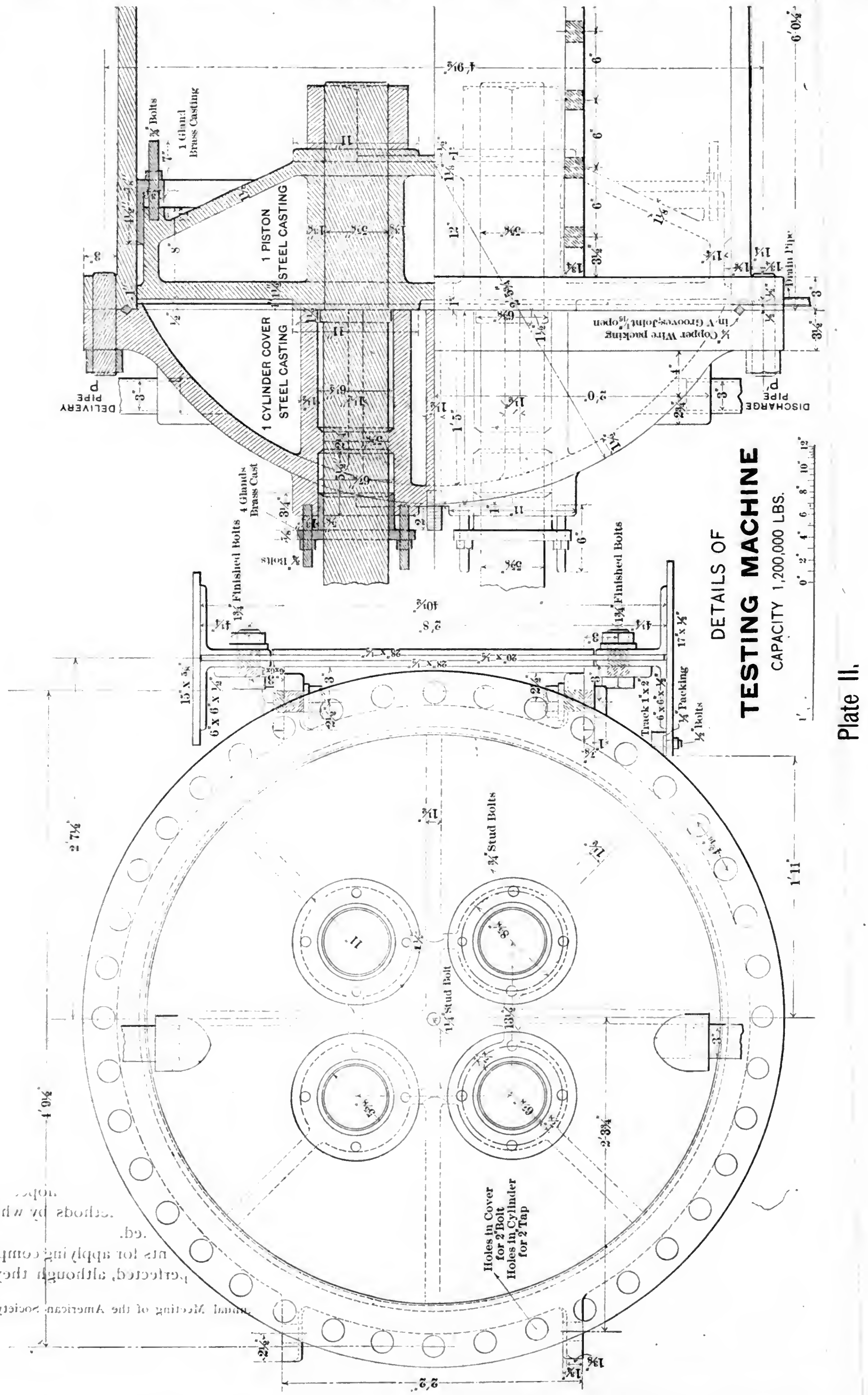
A BRIEF description of a testing machine capable of exerting a tensile strain of 1,200,000 pounds, recently constructed at the works of the Union Bridge Company, at Athens, Pa., and successfully applied in pulling to destruction a number of eye-bars of unusually large dimensions, may prove of interest.

In general it may be described as consisting of a hydraulic cylinder securely fastened between two longitudinal girders, which form the frame of the machine; a tail block attached to the webs of the girders at convenient intervals, and two connecting blocks to receive the test pieces, attached respectively to the piston of the cylinder and the tail block. They are carried upon finished wheels, running upon an accurately lined and finished track resting upon the lower flanges of the girders. The strain upon the test piece is assumed to be equivalent to the hydraulic pressure upon the piston, which is measured by a Shaw mercury column and a spring gauge, both being referred to the center of the cylinder. The stretch is recorded upon a natural scale.

A reference to the drawings will indicate the details of this simple piece of mechanism, and, it is hoped, furnish evidence of the accuracy of the methods by which important results have been obtained.

Inasmuch as the arrangements for applying compression strains have not yet been perfected, although they are in

* Paper read at the Annual Meeting of the American Society of Civil Engineers.



DETAILS OF
TESTING MACHINE
CAPACITY 1,200,000 LBS.

Plate II.

a forward state of preparation, your attention is directed to the machine as at present adapted to tensile strains only, reserving to the near future a presentation of the completed machine.

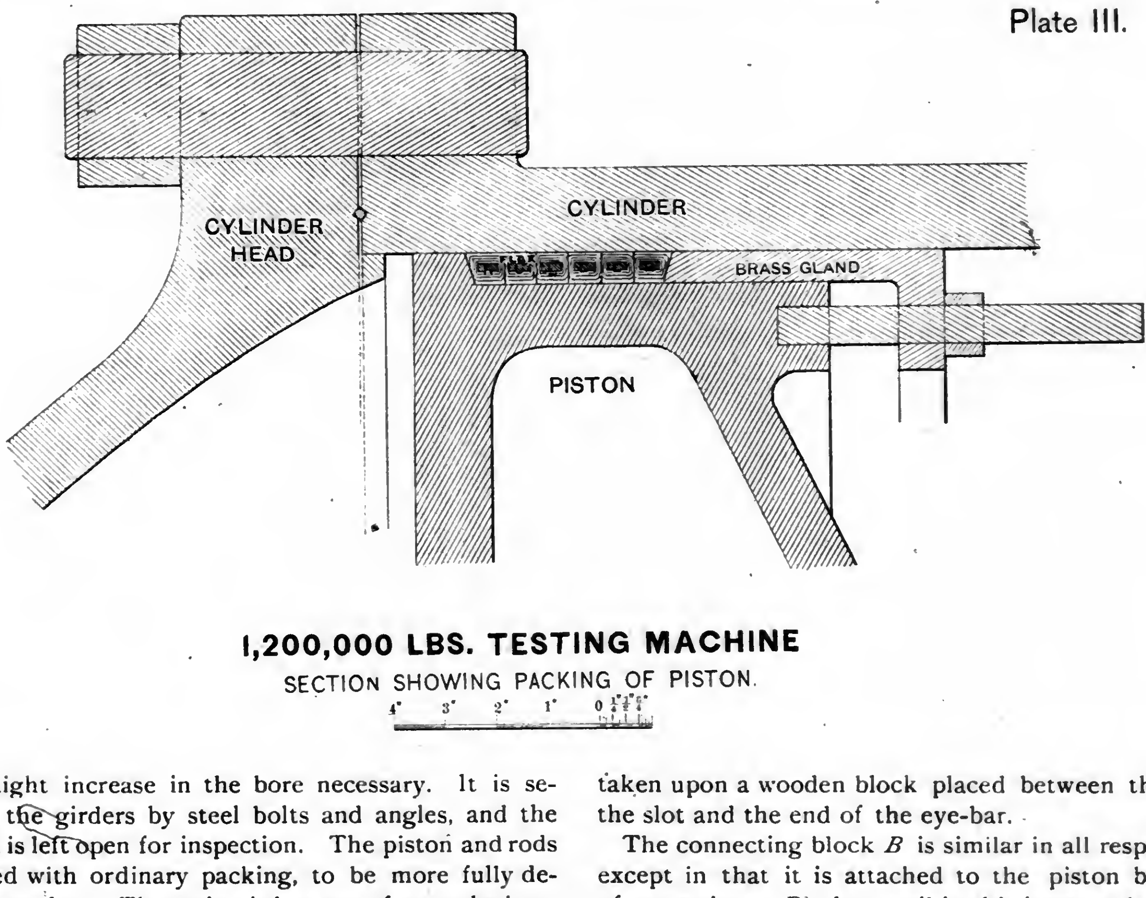
Plate I represents a general plan and elevation with sections. The cylinder is of cast-steel, 4 feet 3¾ inches diameter and 6 feet 0½ inch long, giving an effective area of 2,039 square inches, and a working stroke of 4 feet 11 inches. The maximum water pressure for which provision has been made is 600 pounds per square inch, which, for a piston area of 2,039 inches, produces a total strain upon the test piece of 1,223,400 pounds, under the assumption, which is believed permissible, that the resistance due to friction is sufficiently small to be neglected. For the purpose of facilitating observations, it is intended that the cylinder should have an effective area of exactly 2,000 square inches, so that one pound upon the gauges would indicate a ton of pressure, but a defect in the casting made a slight increase in the bore necessary. It is secured to the girders by steel bolts and angles, and the outer end is left open for inspection. The piston and rods are packed with ordinary packing, to be more fully described hereafter. The main girders are of wrought-iron, 60 feet long by 3 feet 5⅝ inches high, built up of plates and angles rolled in one length. Holes are bored through the webs, 6½ inches diameter and 18 inches apart, for convenience of attachment of the tail block; along this portion of the webs the thickness of the metal is 2½ inches. They rest on, and are secured to, 12-inch cross-girders, which are bolted to masonry foundations. The top flanges are held in line by cast-iron brackets *G*.

The tail block *A* is a steel casting, which may be attached to the girders, at intervals of 18 inches, by two short steel pins, on either side, 6½ inches in diameter, and any intermediate adjustment is obtained by four geared steel nuts *C*, working on rods D^2. These nuts are turned by a central pinion on the shaft *E*, the nuts, pinion and shaft being contained in the plate-box *F*.

The connecting block B^2 is a slotted steel casting resting on wheels, and attached to the tail block *A* by four steel rods D^2, 5⅝ inches in diameter, having the adjustment at *F* above described. Provision is made for recoil by a steel rod, *H*, fastened to B^2, and passing through a brass friction-clamp, *I*, in the tail block. It will be observed that the rods D^2 are held fast in the block B^2 by double nuts, while they are free to push through the tail block *A*. The effect of recoil at this end is therefore controlled by friction upon the rod *H*, and the amount of the friction required for that purpose is regulated by adjustment in the clamp *I*.

A vertical slot, disposed centrally between the rods D^2, admits the head of the eye-bar, which is secured by a pin passing through a pin-hole 7½ inches diameter, and slotted 1½ inches. When smaller pins are required, collars are added to fill. The object of this elongation of the pin-hole is to admit of recoil in the test piece itself—a not inconsiderable quantity in large bars. This recoil is taken upon a wooden block placed between the back of the slot and the end of the eye-bar.

Plate III.



1,200,000 LBS. TESTING MACHINE

SECTION SHOWING PACKING OF PISTON.

The connecting block *B* is similar in all respects to B^2, except in that it is attached to the piston by rods *D*, of same size as D^2, the recoil in this instance being transmitted without injurious effect upon the piston.

Plate II is an enlarged view of cylinder head and piston, showing the copper-wire packing between head and barrel, also the piston and piston-rod packing, and the connection of cylinder with main girders.

Water is delivered from the pump through the pipe *P*, 3 inches diameter, and is discharged through P^2, of the same diameter, into a tank outside the building. The vertical distance from center of the cylinder to the surface of the water in this tank is 4 feet 6 inches.

Plate III illustrates on still larger scale the detail of the piston packing. A sample of the packing itself is also submitted with the paper; it does not differ from that in general use, and is too well known to require description. This packing is "set up" by a brass gland and packing bolts, with thread and nut adjustment, until

the leakage, under maximum pressure, is reduced to a thin film of water discharging uniformly about the periphery of the piston. After a test has been completed and the piston remains at a distance from the head of the cylinder equal to the stretch of the piece, it is brought back to a normal position by opening the discharge cock in the pipe P^2, and allowing the water to pass out under the head of 4 feet 6 inches, when it is found that the partial vacuum thus obtained, which is equivalent to 1½ pounds per square inch upon the piston, is sufficient for the purpose. This is equal to about three thousand pounds total pressure, and, inasmuch as the pressure upon the packing when properly adjusted by its gland for a maximum water pressure is believed to be a constant quantity, it is assumed that three thousand pounds represent the maximum reduction which should be made as compensation for frictional resistance. This is scarcely one-quarter of one per cent. of the highest strain indicated by the gauges, and for all practical purposes it may be disregarded.

Pressure is supplied in the cylinder by a pump having three single-acting plungers, 2¼ inches diameter and 10-inch stroke, working at slow speed, and giving steady and uniform movement to the piston. An engine having two cylinders, 8 inches diameter by 8 inches stroke, is sufficient to work the pumps with such regularity that little or no fluctuation is noticeable in the gauges.

Under the maximum pressure for which the machine has been designed, the principal members are subjected to initial strains up to the following limits:

Main girders.........	7,100	pounds compression per square inch.
Steel castings........	15,000	" " " " "
" "	13,000	" tension " " "
" connectings rods	15,000	" " " " "
" bolts............	12,000	" shear " " "

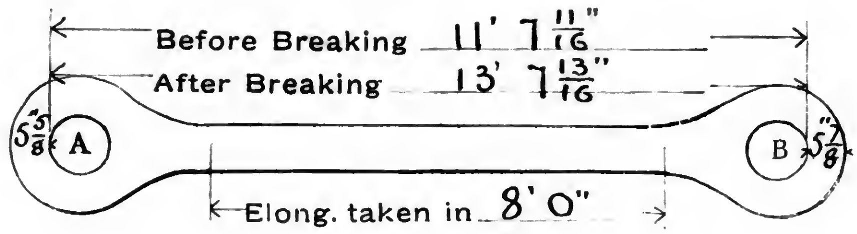
All strains are referred to the net or effective sections, and this margin of safety appears to be sufficient to provide against injury from the sudden release of strain at the moment of rupture of test piece.

A fragment of a steel bar, 8 by $1\frac{15}{16}$ inches section, which has been tested to rupture on this machine is exhibited herewith; upon it will be found a full record of the test, in regular form, as follows:

WORKS: UNION BRIDGE COMPANY,
ATHENS, PA. CIVIL ENGINEERS AND CONSTRUCTORS OF BRIDGES,
Late Kellogg & Maurice. NEW YORK OFFICE, 18 BROADWAY.
Capacity, 14,000 tons.
BUFFALO, N. Y.
Late Cent'l Bridge W'ks,
Capacity, 12,000 tons.

Test No. 20. TESTING DEPARTMENT,
Contract No.... AT ATHENS, PA.,
Original Mark, M. October 29, 1886.

Full-sized test of Hawkesbury Bridge Steel Eye Bar, rolled by Steel Company of Scotland. Manufactured by Buffalo Shop, Union Bridge Company.



Head: Dimensions, $18\frac{1}{16} \times 1.98$ in. Excess, 41.4 per cent.
Head: Dimensions, $18\frac{1}{16} \times 1.95$ in. Excess, 45.7 per cent.

Diameter of pin-hole, 7.03 in. Diameter of pin-hole, 6.52 in.
Elongation of pin-hole, 1.18 in. Elongation of pin-hole, 1.60 in.
Nominal section, $8 \times 1\frac{15}{16}$ in. Actual section, 8×1.93 in.
Original area, 15.44 sq. in. Fractured area, 6.22×1.20 in. = 7.464 sq. in.
Gauge reading for elastic limit.... ...273 = 556,815 pounds.
" " ultimate strength, 503 = 1,025,920 "
Elongation in 12 in., 4½ in. Elongation in 8 feet, 1 ft. $1\frac{13}{16}$ in.

Elastic limit..........................	36,063 pounds per square inch.
Ultimate strength......................	66,445 " " " "
Elongation in 12 inches..........................	...37.5 per cent.
" 8 feet..........................	20.76 "
Reduction of area at fracture....................	= 51.65 "

Fracture fibrous and silky, excepting little fine crystal on edges.

REMARKS.

Elongations in 8 spaces of 12 inches each:
(A) 1 ft. 11⅝ in. + 1 ft. $1\frac{13}{16}$ in. + 1 ft. 2 in. + 1 ft. 1¾ in. + 1 ft. 2 in. + 1 ft. $2\frac{9}{16}$ in. + 1 ft. $2\frac{15}{16}$ in. + 1 ft. 4½ in. fracture + 1 ft. 2⅜ in.

This material was required to stand 67,000 to 74,000 pounds per square inch on sections of ¾-inch diameter.

UNION BRIDGE COMPANY,
By MILLARD HANSIKER, Inspector.

In operating the machine, the tail block *A* is attached to the web of the girders at the nearest range of holes corresponding to the length of test piece; the block B^2 is adjusted to exact position by the spindle *E*. The test piece is lowered into the slots by an overhanging traveler, and when the connecting pins are driven the pressure may be applied. Upon starting the pumps the gauges begin to rise at a uniform rate, and continue until, for a moment they cease to move, which fact is assumed as indicating permanent set. After this limit is passed the advance is at a gradually decreasing rate until the ultimate or highest pressure is reached; at this point they remain stationary, or with very slight vibrations, often for a considerable time, the stretch in the piece meantime continuing with increasing rapidity. When the stage of actual rupture is initiated the gauges begin to fall, slowly at first, afterwards with rapidly increasing rate, until the piece is broken. In order to prevent injury to the gauges by the sudden reduction of pressure at this instant, small check valves are placed in the supply pipes just under the gauges. They are light, and close by gravity, allowing the pressure to be relieved gradually.

The effective length of the cylinder being, as already stated, 4 feet 11 inches, it is possible to stretch a specimen to that limit before withdrawing the pressure in order to set back the tail block. This represents 12 per cent. stretch for an eye-bar 40 feet long, which is the limit of the machine, and for a great majority of cases this range is in excess of the ultimate strength.

From this it appears that the maximum strain applied was 1,025,920 pounds, or 66,445 pounds per square inch on original area of $15\frac{44}{100}$ square inches. The remaining portion of this bar has been sent to Mr. B. Baker, M. I. C. E., in London, as a specimen of the material and workmanship for the Hawkesbury Bridge, for which tests were required.

Numbers of bars, ranging in section from 5 to 18 square inches, have been tested with similar results, and without

the slightest injurious effect upon the machine. The largest bar thus far strained to rupture was 8 by 2¼ inches section by 14 feet 10 inches between bearings on pins, the material being open-hearth steel, specified to stand 67,000 to 74,000 pounds per square inch on small specimens, ¾ inch diameter. In this case the maximum strain was 1,187,000 pounds, or 66,539 pounds per square inch on the original area. Two steel bars, 8 by 2⅜ inches in section, have been strained up to 1,223,760 pounds without causing rupture, when it was thought prudent to discontinue the tests.

It has been previously stated that, at the moment of rupture, a considerable reduction of strain is indicated by the gauges. A few observations of this reduction have been made; and, as a matter of interest, it may be stated that, in the case of the fragment exhibited, the strain per square inch at the moment of fracture, referred to the original area, was 57,464 pounds per square inch, as against 66,445 pounds maximum indication before final reduction began. If the area at point of fracture be considered, the actual strain upon that area was 118,867 pounds per square inch.

Your attention is called to the flow of metal at the zone of fracture, to the elongation of pin-hole, and in fact to the general appearance of the fragment as a whole, indicating, as it does, far better than any mere verbal description, the capacity of the machine.

At the present writing its sphere of usefulness is limited to the testing of tension members, not exceeding 40 feet in length, to a maximum strain of 1,200,000 pounds. The largest pin-hole provided for eye-bars is 7½ inches diameter, but flats, rounds and squares can be tested without pins by a simple attachment to the connecting blocks. When the plans for applying compressive strains are perfected, it will be possible to test specimens up to 32 feet in length and 800,000 pounds pressure.

The machine was designed by Mr. Charles Kellogg, Member of the Society. The late Mr. J. L. Marsh rendered valuable service to Mr. Kellogg in the preparation of plans and in superintending the construction. His death occurred immediately after its completion.

It is not contended that this is an instrument of precision, as for experimental research, or that in sensitiveness or minute accuracy it is the equal of the United States testing machine at Watertown Arsenal. Mr. Kellogg himself would be the last person to invite comparison in that respect with the superb invention of Mr. A Emery. What he has accomplished has been the construction of a machine, at moderate cost, which will test to destruction full-sized sections, as they are required for structural purposes, with rapidity and reasonable accuracy, of which the records submitted are sufficient evidence.

In reply to an inquiry regarding the Watertown machine, the writer has been favored with the following information by F. H. Parker, Major Ordnance Department, U. S. A.

"A description and account of the machine is published in the Annual Report of the Chief of Ordnance, U. S. A., for 1883. From that you will see that the capacity of the machine is 800,000 pounds for tension tests and 1,000,000 pounds for compression. In the combination of the qualities of accuracy, sensitiveness, and convenience of manipulation, it is believed to stand alone, and precautions have been taken to prevent injury by recoil or reaction.

"The machine is continually operated not only in testing large members of structures, but also small band specimens where the greatest accuracy is desired; and it is necessary to use it in such a manner as will in no degree impair this latter quality.

"The machine has frequently broken bars to nearly its full capacity; but, in view of the constant demands made for accurate work in testing cannon metal, and in making tests for industrial purposes, it is not thought advisable to run any risks of injury or delay by breaking bars of great length and large cross-section combined. The testing of such bars is carried far enough to give, probably, all useful information required.

"Government work on the machine occupies a great deal of the time; but considerable work for private parties is done."

From all of which it would appear that the magnificent piece of mechanism from which we had hoped to derive such valuable information, which was so admirably described by the late A. L. Holley, M. Am. Soc. C. E., in a paper pead before the Institute of Mining Engineers, Vol. VII., 1879, and for which not a few of our Members devoted valuable time and "influence" at Washington in quest of an "appropriation," is, in all probability, destined to occupy an honorary position in engineering science, and will be quite beyond the reach of engineers in the active practice of their profession.

Perhaps this is a consummation for which we should be devoutly thankful. It is un-American, to say the least, to approach the General Government for assistance, except in such cases as may be fairly considered beyond the reach of individual enterprise. It was thought at the time of the agitation for a Government testing machine, that the great expense of its construction was a sufficient reason why it could not be undertaken by private means, and this was true so long as the question was complicated by a desire to secure an instrument which was alike suited for laboratory experiments and the testing of large sections. It was a mistake, however, to attempt the construction of such a machine. The two lines of investigation are separate and distinct, requiring mechanical appliances differing as radically as do the amounts of applied strain; hence it would have been far better, and cheaper in the end, to have have built two machines, one of which should be adapted to delicate work upon small specimens, and the other of sufficient power to develop the strength of full-sized members without attempting to secure minute accuracy in the measurement of ultimate strains.

In this connection, engineers are more particularly interested in the working properties of structural material in its completed form; and a machine which will develop these properties expeditiously, and at moderate cost, commends itself, without inviting invidious comparison with others having different objects in view.

THE new railroad mileage built last year, according to statements recently published, reached 8,100 miles, a total which has been heretofore exceeded only twice. The greater part of last year's new mileage was west of the Mississippi river, both the Northwest and the Southwest coming in for a share. The building of parallel lines, which has, for the present, practically ceased in the Eastern states, is now very active in the West. Much of this is due to the rivalry of the great Chicago and St. Louis companies, and their fear of losing business should a competing line be the first to take the business of a new district.

Resistance of Trains on Railways.*

BY — DESDOUITS.

(*Annales des Mines*, 8ª Serie, Vol. viii., 1885, p. 481.)

In this article the author gives the results of a long series of experimental investigations of the resistance of locomotives and trains on railways.

The resistances due to the rolling of the wheel-flanges and the sliding of the axles on the bearings are taken together as the resistance to rolling, the one and the other element being taken as proportional to the load, and the joint resistance being taken at so much per ton. But the resistance of the atmosphere varies in wide proportions, not with the load, but with the forms and the grouping of the vehicles. Besides, the element of atmospheric resistance considerably preponderates in the composition of the total resistance, for high-speed trains at least.

From a geometrical point of view, trains of all kinds belong to one of two classes—passenger trains and goods trains. The first are regularly and compactly formed, the second are irregular and more widely connected. The elementary train, as it is called—engine, tender, and brake-van—is the first submitted to experimental investigation. For resistance at very low speeds, when atmospheric resistance is a minimum and may be neglected; and afterward at high speeds when the law of atmospheric resistance may be determined. For each experiment the engine is in steam, and the regulator is slightly opened, so as to obtain a conveniently low initial speed of from 3¾ miles to 5 miles per hour (6 to 8 kilometers); then the steam is shut off, and the stopping of the engine, by its own proper resistance, is observed. The four series of engines in regular service have been submitted to experiment, of which the leading features are here tabulated:

Designation of Locomotive.	Axles.	Wheels. Diameter. Ft. Ins.	Cylinder. Diameter. Ins.	Cylinder. Stroke. Ins.	Weight. Engine. Tons.	Weight. Tender. Tons.	Weight. Total. Tons.
1. High speed..	3 axles, 2 coupled	6 7½	17.3	25.6	36	16	52
2. Mixed speed.	3 " coupled	4 11½	16.5 / 18.5	23.6	32	16	48
3. Goods speed.	3 " "	4 4	17.7	25.6	36	16	52
4. Goods speed.	4 " "	4 2	21.3	26.0	54	16	70

The cylinders of all these engines are outside. The high-speed engines have the Stephenson link-motion, with valves of two kinds—ordinary slide and cylindrical.

The mixed engines have ordinary slides. The three-axle goods engines have the same, and the four-axle engines have cylindrical valves.

A dynamometer of special construction, with pendulum movement, was fixed on the platform of the tender. The regulator was gently opened, so as to give a speed of about 6 miles per hour; then suddenly closed, when the engine was left to come to a state of rest, without the use of the brake on the tender. A diagram of uniform resistance was described. The observation was repeated three or four times backward and forward on the same piece of line, making a passage of from 110 yards to 160 yards. According to another system of observation, the time taken for each revolution of the driving-wheels in the course of the run was noted, and thence the speed and the retardation were calculated

* From Abstracts of Papers in Foreign Transactions and Periodicals, published by the Institution of Civil Engineers.

It is of essential importance that the state of the experimental way should be, if not perfect, at least in average condition, as for a portion of the main line. This condition is often but imperfectly realized in stations and goods yards. The locomotive, also, should be in at least average good order, working freely, stuffing-boxes not unduly tight, bearings free, lubrication good, tender-brake quite clear. The engine should have made a run since being lighted up, in order to bring all the moving parts into a proper state of lubrication, and to their normal temperature. An engine cold, and taken direct from a state of rest, though well oiled, usually has a surplus of resistance of from 30 to 50 per cent. Newly repaired engines have shown nearly double the normal resistance.

The state of the atmosphere affects the resistance. A head wind of 16 feet per second would suffice to double the resistance at a speed of 5 miles per hour. The resistances are deduced from velocities diminishing from 5 miles to 2½ miles per hour.

From the detailed tables given of the observed resistances of the engines tried, the following summary of the resistances in pounds, per ton of gross weight of engine and tender, has been prepared:

Designation of Engines.	Resistance per ton of Engine and Tender. Slide-Valves. Stephenson Link. lbs.	Cylindrical Valves. Stephenson Link. lbs.	Cylindrical Valves. Walchaërts Gear. lbs.
1. High speed........	6.94	....	5.82
2. Mixed.............	8.06	8.06	....
3. Goods (three-axle).	10.53	....	....
4. Goods (four-axle)..	....	....	9.18

It appears that the engines fitted with cylindrical valves and the Walchaërts gear have a marked advantage over those of the ordinary type of gear. Comparing the two high-speed engines, there is an advantage in reduction of resistance with the modified gear of 1.12 pounds per ton, or 16 per cent. Again, the four-axle goods engine, having the modified gear, has 1.34 pound per ton less resistance than the three-axle goods, although the four-axle engine has the smaller wheel, and the larger dimensions of cylinders and mechanism. The mixed engines have equal resistances of about 8 pounds per ton. In this case the transformation was only partial, and with the introduction of the cylindrical valves the old Stephenson gear was retained, and it was constructed with a return movement. The diameter of the cylinders, also, was augmented.

These causes of supplementary resistance are compensated by the modification of the valve-gear.

The resistances above announced are noticeably less than those which are generally assigned to like engines, according to earlier experiments. The difference probably arises, for the most part, from the higher speeds at which these were made.

RESISTANCE OF THE MACHINERY OF LOCOMOTIVES.

Experiments were made with a high-speed engine, a mixed engine and a four-axle engine. For each experiment an auxiliary engine in steam was employed to get up the speed of the engine on trial—from 4 to 5 miles per hour—afterward putting on its brake. The retarded movement of the engine was then noted. The reverse movement was given by a second auxiliary engine. Each engine in working order was also tried in steam. The results are here tabulated as follows:

MACHINERY—RESISTANCE.

Designation and Condition.	Resistance per ton. Pounds.	Total Resistance. Pounds.
1. High-speed engine, with flat slide-valves, entirely mounted, in steam (weight, including tender, 52 tons)	7.17	373
The same engine, connecting-rods, valve-gear and coupling-rods dismounted	5.26	274
Say, for all the movable pieces	1.91	99
2. Mixed engine, with flat slide-valves, entirely mounted, in steam (weight, including tender, 48 tons)	8.06	387
The same engine, connecting-rods and valve-gear dismounted	5.04	242
Say, for the mechanism	3.02	145
The same engine, with the connecting-rods, coupling-rods and valve-gear dismounted	4.93	236
3. Goods engine, four-axles coupled, with cylindrical valves, entirely mounted, in steam (weight, including tender, 70 tons)	8.96	627
Same engine, connecting-rods and valve-gear dismounted	6.94	486
Say, for the mechanism	2.02	141
Same engine, connecting-rods, coupling-rods, and valve-gear dismounted	6.94	486

These results show that the mechanism absorbs from 27 to 22 per cent. of the whole resistance of the engine. For the mixed engine and the four-axle engine the resistances are nearly the same. The influence of the coupling rods is scarcely appreciable.

RESISTANCE OF THE TENDER ALONE.

The results of trials made with tenders separated from the engines give from 5.60 to 6.27 pounds per ton for resistance, ranging about the same as that of the engines or carriages.

RESISTANCE OF PASSENGER CARRIAGES AND VANS.

From the results of trials with trains of seven and eight vehicles lubricated with colza oil and with mineral oil, the resistance was at the rate of 3.47 pounds and 3.58 pounds. The wheels were 3 feet 5 inches in diameter, with journals 3½ inches by 7 inches, and loaded to 4 and 5 tons, respectively, per axle. The temperature during the trials was 59° Fahrenheit.

RESISTANCE OF GOODS WAGONS.

A train of thirty wagons, weighing in gross 300 tons, was tried. It was lubricated with colza oil, having wheels and journals like those of the carriages. The resistance of the engine, tender and train—the engine and tender weighing 70 tons—was at the rate of 4.93 pounds per ton, or for the train, separately, 4.10 pounds per ton.

It is concluded generally for all sorts of vehicles under conditions of lubrication like the vehicles tested, that a resistance without speed of from 3.36 to 4.03 pounds (1.50 to 1.80 kilograms per tonne) per ton may be accepted with an extreme limit of 4½ pounds per ton. Greater resistances than these arise from defective lubrication or atmospheric resistance.

RESISTANCES AT HIGH SPEEDS: ATMOSPHERIC RESISTANCE.

Experiments were made on the resistance of the air to flat boards suspended laterally from a train, movable on axles and counterweighted. The train was run at increasing velocities, and the instant was noted when the resistance of the air, preponderating, caused the lifting of the weights and reversal of the board. It was deduced from experimental results that (1) the resistance on a surface 1 decimeter square (3.94 inches square), in absolutely calm weather, at a speed of 44½ miles per hour, amounted to 0.52 kilogram, or 1.14 pound, being at the rate of 106 pounds per square foot.

For other velocities the variation of resistance is sensibly as the square of the speed; and within practical limits, the extent of the surface does not sensibly affect the coefficient of resistance.

The resistance to pressure may be reduced one-half by the adoption of angular prows. A locomotive was fitted with angular prows on the smoke-box, buffer-beam, footplate fence and other parts. The back of the tender was fitted with an angular tail-piece, and the wheel spokes were covered in with sheet-iron. The resistance, at a speed of 43½ miles per hour, was by means of these fittings reduced 9 pounds per ton. This engine, thus fitted, was kept on regular duty for a period of six months working omnibus trains. The results, compared with the average results from four engines of the same class in ordinary condition, were as follows:

	Average Tonnage. Tons.	Consumption Per Mile. Pounds.
Four engines in average condition	93	22
Modified engine	94	19

showing an economy of about 14 per cent. in favor of the modified engine.

The author proceeds to develop formulas for the resistances of engines and trains at high speed. He recognizes the principle of the variation of all the resistances as a whole, as the square of the speed.

Her Majesty's Ship "Narcissus."

THE London *Times* gives the following description of a new belted cruiser, which was launched on December 15th, which will be of interest in this country at the present time, when we are thinking a good deal about war ships:

"The vessel is 300 feet long on the load-line, has a breadth of 56 feet and a molded depth of 37 feet, with a draught of about 21 feet. Protection is afforded by a belt of steel-faced armor, 10 inches in thickness, extending the whole length of the boiler and magazine space, thus protecting the most vital parts of the ship. The *Narcissus* has been built in ram form, her ram being of steel, the latest arrangements being adopted for strengthening and stiffening. Her stern-frame is also of cast-steel, and, with the ram, was supplied by Messrs. Jessop & Son, of Sheffield, while the crutches for the twin propellers, also of steel, are by John Brown & Company, Sheffield. With regard to the armor belting, it may be stated that it is 200 feet in length, extending from 1 foot 6 inches above the water-line to 4 feet below. This belt of 10 inches is backed with 6 inches of teak, secured in steel plating 1 inch thick. On a level with the top of the belt there is a protective deck, which extends the whole length of the vessel. In the way of the belting this deck is perfectly horizontal, and is formed of steel plating 2 inches thick. Beyond the belting, the deck is declined downward to an angle of 30°, and it is here 3 inches in thickness, so that fore and aft a sort of turtle-back is formed. All the openings in this protective deck are fitted with either armor shutters or shell-proof gratings. By means of the armor

belt amidships, and the protective deck-plating fore and aft, the whole of the vessel under this deck is rendered invulnerable to shot and shell, and forms an unsinkable raft, in which are placed the engines, boilers, magazines, shell-rooms and steering gear. When in action, the movements of the machinery, the steering of the ship and the firing of the guns are under complete control from the conning tower or pilot house, a massive structure at the fore end of the vessel. The look-out men in this tower are protected by 12-inch steel-faced armor, and all the communications to the engine-rooms, magazines, steering wheels, etc., pass through a tube of steel, 8 inches thick. It will thus be seen that everything possible is done for the protection of the crew, and to insure the safe working of the ship when in action. The hull of the vessel is of Siemens-Martin steel, and, altogether, there are over 100 water-tight compartments. As a still further protection to the ship, she is built on the double-bottom cellular principle, and has provision for water ballast, fore and aft, for trimming the vessel. The vessel has steam steering-gear, and the whole of her machinery is placed under the protective deck, and steam connections will be made to the conning tower forward and the lower deck forward, while hand steering-gear will be placed on the protective deck aft. The berthing of the crew, about 420 all told, will be similar to that which is common on board the vessels of Her Majesty's Navy. The lines of the vessel are specially designed for a high rate of speed, about 19 knots it is expected, and altogether she presented, as she went afloat, a very beautiful appearance.

"The armament of the *Narcissus* consists of one 10-inch breech-loading gun in the center of the citadel. This powerful gun is mounted on Vavasseur's center-pivot automatic carriage with a central hoist for passing up the ammunition by steam-power close to the breech, no matter in what direction the gun may be trained. There are also in the citadel five guns on each side of the ship, each 6 inches, similarly mounted to the central gun. Each of the end guns is on a sponson, so that it can be trained, the forward ones right forward and the after ones right aft, in a line with the ship. When the ship is in action, the protective deck can be cleared of all obstruction, the stanchions, bulwarks, bollards and everything being so arranged that they can be laid flat on deck. On the 'tween decks there are ten of the Hotchkiss quick-firing guns. In the center line, still on the 'tween decks, there are two 9-pounder guns, one forward and the other aft. The vessel will be rigged with two jury-masts with tops, sufficiently spacious to allow of the working therefrom of machine guns.

"The engines, which are also being constructed by Earle's Company, are of the horizontal, direct-acting, triple-expansion type, the diameter of the cylinders being: high pressure, 36 inches; medium, 51 inches; and low pressure, 78 inches; with a length of stroke of 42 inches. The surface condensers are all of brass and provide a cooling surface of 12,000 feet. The frames of the engines are of steel, and the crank-shafting of Whitworth's fluid compressed steel, a portion of the shafting being hollow. The pistons and piston-rods are also of steel, and the connecting-rods of wrought-steel. The engines are fitted with steam gear for starting, reversing and turning. The air-pumps and all connections are of gun-metal. The circulating pumps are of gun-metal, and are driven by independent engines fitted with additional suction valves leading into the bilges, so that they may be used for pumping water out of the ship in the event of a leak. Each circulating pump is capable of discharging 500 tons of water per hour. There are also in the ship two of Normandy's condensers capable of condensing 130 gallons of water per hour, for the use of the ship's crew. Steam is supplied to the engines by two double-ended steel boilers, each 14 feet 6 inches in diameter by 17 feet 6 inches long. At each end there are six of Fox's corrugated furnaces, and the working pressure is 130 pounds to the square inch. The propellers are of gun-metal and are 14 feet 6 inches in diameter."

New British War-Ships.

Two new "belted cruisers" have recently been built and launched, one, the *Undaunted*, by the Palmer Shipbuilding and Iron Company, Jarrow; and the other, the *Australia*, by Messrs. Robert Napier & Sons, Govan.

The *Undaunted* is described as follows in the London *Times*:

"The principal characteristics of this type of vessel are, briefly, a high attainment of speed with great defensive power. They are more like the *Mersey* class than any other, the chief difference consisting in a belt of armor about the water-line which is fitted in the *Undaunted* class, and from which they derive the name of belted cruisers. The following is a general description of the vessel: Length, 300 feet; breadth, extreme, 56 feet; depth, molded, 37 feet; normal draught, 21 feet; displacement, 5,000 tons; indicated horse-power, 8,500; estimated speed, 19 knots. The armor is compound or steel-faced, and consists of a belt 200 feet in length, extending from 1 foot 6 inches above the water-line to 4 feet below. This belt is 10 inches in thickness, and is backed with 6 inches of teak, secured in steel plating 1 inch in thickness. On a level with the top of the belt there is a protective deck, formed of 2 inches of steel plating. Beyond the belt at both ends the deck is inclined downward to an angle of 30°, and is 3 inches in thickness. All openings in this deck are fitted with either armor shutters or shell-proof gratings, and those necessarily open in action are also fitted with coffer-dams. By means of the armor belt amidships, and the protective deck-plating fore and aft, the whole of the vessel under this deck is rendered invulnerable to shot and shell, and forms an unsinkable raft in which are placed the engines, boilers, magazines, shell-rooms, and steering gear. When in action, the movements of the machinery, the steering of the ship, and the firing of the guns are under complete control from the conning tower, a massive structure at the fore end of the vessel. The look-out men in this tower are protected by 12 inches of steel-faced armor, and all the communications to engine rooms, magazines, steering wheels, etc., pass through a tube of steel 8 inches thick. The stem, which forms a ram, is exceptionally strong and is well supported by the framework of the vessel and the protective deck. The ram, sternpost and propeller brackets are each of cast-steel, manufactured by Messrs. Spencer & Sons, of Newburn. The hull is built of Siemens-Martin steel, and is divided into over 100 watertight compartments.

"The *Australia* is one of five belted cruisers ordered in April, 1885. The building of two, the *Australia* and the *Galatea*, was intrusted to Messrs. Napier & Sons, two, the *Orlando* and the *Undaunted*, were ordered from

Palmer's Shipbuilding and Iron Company (Limited), Jarrow-on-Tyne, and the fifth was ordered from Earle's Shipbuilding Company, Hull. The *Australia*, like her sister ships, is 300 feet long between perpendiculars and 56 feet in extreme breadth. The draught of water, under ordinary circumstances, will be 19 feet, and, at this draught, the displacement will be 5,000 tons. This may be at times increased to 6,000 tons, when a full supply of coal is shipped. It is expected that the vessel will have a speed of 18 knots per hour. The engines, which are to be fitted on board, and have been designed by Messrs. Napier, are of the triple expansion type, working twin screws, and will indicate 8,500 horse-power, the working pressure being 130 pounds. It may be interesting to mention that when tenders were asked for vessels of this class, compound engines of 7,500 horse-power were specified, but Messrs, Napier proposed, as an alternative scheme, to fit triple expansion engines on board, and undertook to develop 8,500 horse-power, and that without taking up any more room in the ship or increasing the collective weight of the machinery and coal. The Admiralty accepted this proposal, and carried it out in the other ships of the class. The result will be to increase the speed by about a knot per hour, while less coal will be consumed. The boilers are of the double-ended multitubular type, and have corrugated flues. The armament will consist of two very long range 9¼-inch Armstrong guns, ten 6-inch guns of the same class, all mounted on central-pivot Vavasseur mountings, eight 6-pounder and eight 3-pounder quick-firing guns, also six torpedo impulse tubes. The two striking characterics of the ship are her high rate of speed and length of gun, or range of fire. These qualities would generally enable her to overtake an enemy, or to avoid one altogether if too heavy metal for her; or, using her great speed, she might keep the enemy within the range of her big guns, while she herself was beyond the enemy's fire. Every safeguard has been adopted to shield her from the enemy's fire, and to prevent her from sinking. She is divided into about 130 compartments or cells. The engines and steering gear are all under the water-line, and are protected from *débris*, and from dropping fire, by a 2-inch thick steel deck extending the whole length of the ship. The water-line of the ship is protected by an armor belt 10 inches thick, steel-faced strongly supported by teak and steel backing, and capable of resisting a shot or shell from 10-inch guns."

The Waste of Water in Town Water Supplies.

(From *The Engineer*.)

We have from time to time noticed the investigations of municipal engineers in connection with the waste of water and its prevention. When properly understood, the sum of all the information now available assumes a significance of which few but those who have made the investigations have the slightest idea. A recent report by Mr. Alexander R. Binnie, M. Inst., C. E., waterworks engineer to the Bradford Corporation, places the subject in a striking light; and it is important that Mr. Binnie's work in Bradford should be more widely known. Let us, however, in the first instance, say that this subject of the waste of water and its advocated suppression is not, as appears to be too often ignorantly supposed, the outcome of any desire for niggard supply or parsimonious use, Precisely the opposite view has been consistently held by those who have been most energetic and successful in the suppression of waste. All that is demanded is that so far as possible the water shall be led without waste *to* the consumer's fittings, where he may draw to his heart's content.

Thus, Mr. Binnie, in his recommendations to the Corporation of Bradford, pointed out last year that "by the prevention of waste is not to be understood that it is either contemplated or desired to deprive our customers of one drop of water which they can reasonably or even lavishly require for any useful purpose. Briefly, it may be summed up as an attempt to stop that continual flow of water which is always going on in large towns, and which, in a great measure passes through the pipes not only without doing good to any one, but in many instances in a manner quite unknown and unthought of by the great bulk of the consumers." And again, in 1882, Mr. Deacon, who had been so signally successful in suppressing the waste in Liverpool, and introducing constant supply with great financial benefit to the Corporation, said at the Society of Arts: "The prevention of the waste of water is not, in any sense, a restriction of the use or misuse of water by the consumer, but may even conduce to the greater use or misuse by rendering the water more readily available, under high pressure, and at all times. Not that misuse is a good thing, but that absolute absence of restriction is, I think, a good thing. It would be better to allow a gallon to be misused than, even if there were the power—which there is not—to prevent it, to restrict the proper employment of a pint."

It is, in short, no part of the water authorities' business to inquire how the consumer uses the water, subject, of course, to his not employing it for trade purposes. It is the authorities' duty to lay the water on, and to maintain a high and constant pressure; and it has been shown beyond all question that this can be done with profit to the authorities, and without any interference with the consumer, even to the extent of entering his premises, unless unnecessary waste, previously ascertained by external means, is actually taking place within those premises.

"It is," says Mr. Binnie, "eleven years since I began to urge the necessity of some effective steps being taken to prevent the waste which I at that time proved to be going on." But it was not until August, 1885, that the Corporation of Bradford determined, upon his recommendation, to institute a proper and efficient system for the prevention of waste of water. In his report of October 1st, 1886, giving the results of his first thirteen months' work, Mr. Binnie writes concerning the prevention of waste: "The system which you determined to adopt to effect this latter object was arrived at after an inquiry as to what had been done in other towns, and an experimental trial extending from October, 1884, to July, 1885, the result of which was fully described in my report to you dated the 14th of August of last year. The system on which you determined to work may be briefly described as cutting the town up into a series of small districts, the water supply of each of which is made to pass through one of Deacon's self-recording meters, which registers on a diagram from minute to minute, and from hour to hour, the water passing through it." The meter in question and Mr. Deacon's method have been frequently described, and it is only necessary here to point out that the most important features of the instrument are the two following. (1) That inas-

much as the water way increases as the flow increases, there can be no appreciable loss of head, so that the instrument may be placed in the line of any water-main without in any degree—capable of determination by ordinary pressure gauges—restricting the flow. (2) That the differential diagram drawn by the meter enables one to distinguish between water wasted and water drawn for use. The latter being a steady, uniform flow, produces a steady line of uniform volume; and the former being a constantly varying flow, produces an irregular line of varying volume. Towards midnight the irregular flow rapidly diminishes, and a steady line becomes visible; not yet a line of uniform volume, however, for cisterns are still filling, and the line, steady though it may be, gradually curves towards an asymptote of uniform flow. This asymptote is obviously, therefore, a true measure of the waste. For all practical purposes it may be regarded as coincident with the line of minimum steady flow.

"The amount of waste," writes Mr. Binnie, "having been determined, its source is next sought out, and detected by various expedients, such as night inspections, shutting off portions of the district to detect the particular street, or streets, in which the waste is going on; and afterwards, in a similar manner, each house is isolated until the exact locality of the waste is determined. No attempt is made to limit or control the free and ample use of water for all purposes, and I am happy to be able to say that the supply has been maintained at constant pressure during the whole of the past year." Mr. Binnie next proceeds to explain the results of his work in two districts, the first containing 81,038 persons and 40,643 taps. In this district the total supply of water before inspection was 1,821,200 gallons, or 22.47 gallons per head per day, which in many towns would be thought by no means high.

After inspection and repair the rate of supply was reduced by suppression of waste to 14.35, but there still remained waste, which was calculated from the diagrams to amount to 5.55 galls. per head per day, from which it appears that the 80,000 people of this first district draw off on the average less than 9 gallons per head per day, though the pressure is high and constant. It is not that the supply is limited, or that the employment of water is in any way restricted, but simply that with present domestic habits the people will not, or at all events do not, on the average, take more. We do not advocate the reduction of the water supply of any town to 9 gallons per head per day, or even to 15 gallons, which would cover the residual waste hitherto checked in the Bradford district, and which probably represents the fringe of waste that must always remain when the more palpable cases have been suppressed. It is essential that the supply should always be much in excess of the demand, as indeed it would be in almost every place in the kingdom, if the example of the Bradford corporation were followed After explaining the results obtained in other districts still more recently placed under the system, Mr. Binnie proceeds to report the cost of the work, concerning which he says: "Viewing it in the most unfavorable manner, and taking into account all items of expenditure up to date, including the experimental work noted in my last report, capital charges and working expenses, it amounts to £3,675 9s. 1d. By this expenditure a saving of 472,602,000 gallons has been effected in one year, the value of which to the corporation is £12,799 12s. 9d. per annum, equivalent to a capital sum of £284,436." Thus, according to Mr. Binnie, the value of water saved in the first year is three and a half times the total capital expenditure involved in the purchase and fixing of all the necessary apparatus, including stopcocks outside the houses and the working expenses combined. Spreading this capital sum over twelve years, Mr. Binnie states that the cost per annum is £922, or about one-fourteenth of the annual value of the water saved. We have stated the Bradford results in some detail, not because they are more remarkable than those obtained in other places, but because they constitute the latest contribution to our store of information concerning the enormous benefits which may accrue to water authority and water consumer alike, by a proper and unprejudiced understanding of the subject and by energetic and systematic action; and we heartily endorse Mr. Binnie's congratulations to the Bradford corporation on the result of their first season's work, which, as he says, far exceeds his best anticipations. We shall look with much interest for the completion of this work, which, notwithstanding the great benefit already accruing, appears to be scarcely half finished.

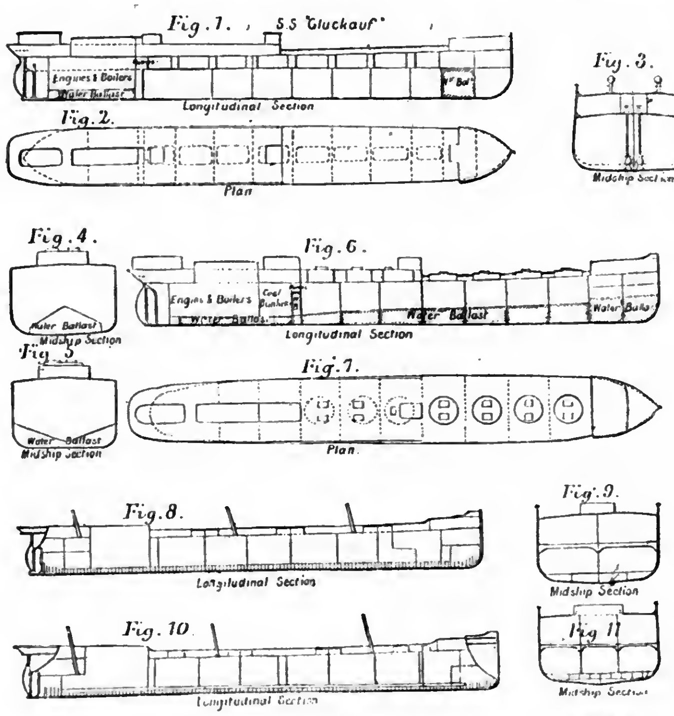
Petroleum Steamers.

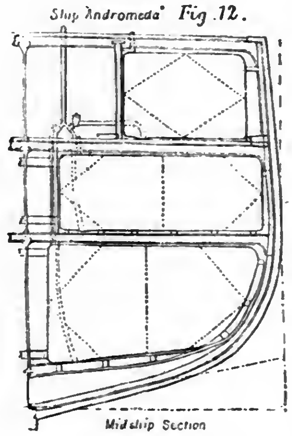
On the 10th inst., an interesting paper was read by Mr. B. G. Nichol, on "The Use of Petroleum," before the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne. Mr. Nichol dealt chiefly with the composition of mineral oils and their heating efficiencies, and he described three different appliances for burning petroleum as fuel, those of Brandt, Sadler and Smith. This paper was followed by a communication from Mr. J. Gravell, surveyor of the Bureau Veritas, describing the most recent practice in the construction of petroleum-carrying steamers. In this communication the writer said that, having had the opportunity, in the capacity of surveyor to the Bureau Veritas, of inspecting the most recently constructed ship for the carriage of petroleum in bulk, viz.: s.s. *Glückauf*, during her entire construction, and again quite recently on the completion of her first voyage, he trusted that some description of her arrangements and their practical effect would not be without interest. Mr. Nichol, as an engineer, had pointed out the immense economic value of liquid fuel, as compared with coal in its calorific effect, its great superiority to coal for steamships in the reduction of labor in firing, in avoiding the necessity for cleaning fires and tubes, in the absence of ashes and scar, and in its requiring no trimming in bunkers. It also possesses special advantages in the promptness with which steam can be got up, and the facility with which the production of steam may be increased in emergency, or instantly diminished almost at will; in the absolute closeness of its stowage, and its adaptation for conveyance in such parts of the vessel as are, from their shape, not available for any ordinary description of cargo. To all these advantages, if we add extreme facility and small cost of shipment, also simplicity of measurement, it would appear that even at a considerably enhanced price, as compared with coal, mineral oil should be adopted whenever it can be obtained, as fuel for steamers.

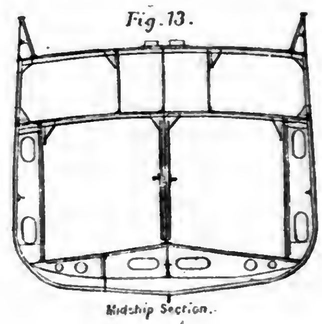
There is, however, a prejudice against the use of liquid fuel, arising from the idea that it is not easy to make com-

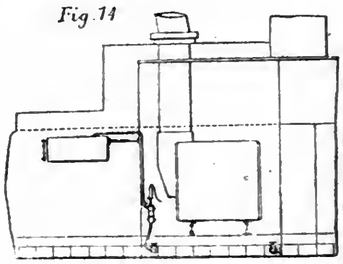
partments tight enough to carry mineral oil in bulk, some shipowners being much affected by vague fears of explosion from leakages and gases which, on account of their vagueness, are very difficult to meet.

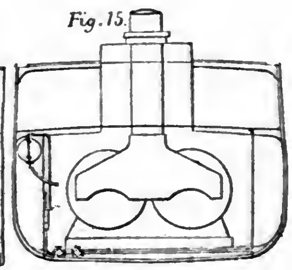
The influence of prejudice is clearly shown in the facts brought out in a very able, and (at its date) exhaustive paper read by Mr. B. Martell, on July 27 last, at Liverpool, before the Institution of Naval Architects. He showed that many years ago the idea of carrying mineral oil in bulk was before the public; but after all these would take from three to four weeks to load a cargo of oil in casks, but with her present arrangements for carrying it in bulk, she can be easily loaded in three days, and even this comparatively short time might be much shortened if necessary. Again, the vessel now carries a sufficient quantity of oil to fill 23,000 barrels, whereas a vessel of exactly the same dimensions, specially built to carry petroleum in casks, could not show more than 12,120 barrels, about 52½ per cent. of the quantity carried in bulk.

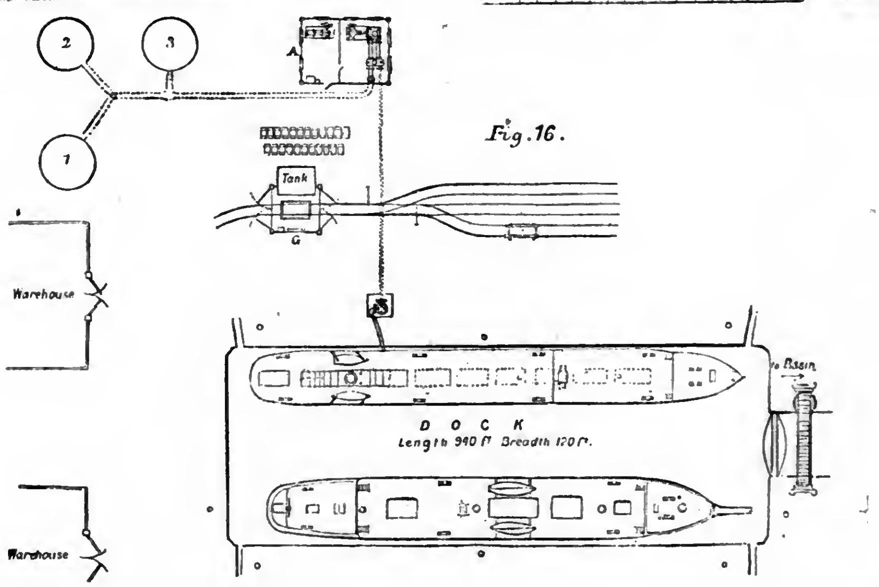












years the old and dangerous method of carrying it in casks has survived and keeps its hold on the bulk of the American trade at this moment, while the efforts at emancipation from the cask monopoly have given rise in succession to the tin-lined case, the small tank, the larger tank, the double-skinned ship, and at last to the most rational arrangement of all, the conveyance of the oil directly against the bare skin of the ship, without tanks and without extraordinary precautions of any kind. The saving derived from carrying petroleum in bulk is an accepted fact. A vessel similar in size to the *Glückauf*

It is hardly requisite to discuss the prejudice which exists against the carriage of oil in bulk, when compared with its carriage in casks, on the score of safety. Of course, it is necessary to take some precautions. For instance, it is important to avoid frothing the oil by allowing it to fall from a height into the receptacle provided for it, and likewise to avoid the churning action which would be produced by the movements of the ship if the compartments were only partially filled, both of which tend to produce gas and deteriorate the oil. It is necessary that the structure and workmanship of the com-

parments should be of a high class, so as to prevent leakage; and if leakage should occur, that it be confined to parts of the ship out of reach of the boiler fires. A provision is required to keep the compartments full, notwithstanding the contraction or expansion of the oil by change of temperature at sea, also for allowing the escape of any small quantity of gas which may be generated, and for the ventilation of empty spaces in the neighborhood of the oil tanks where gas could possibly accumulate. But comparing the facility with which all these matters can be provided for in a ship carrying oil in bulk, with the difficulty, or the impossibility, of doing so in a ship carrying oil in casks, it seems quite clear that if the present innovation was to substitute cask carriage for bulk carriage the outcry against it would be unappeasable. The cask must not be filled quite full or it will infallibly leak, and any leakage would necessarily run through the whole cargo and bilges. The ullage of the cask thus inevitably makes some churning action. The structure and workmanship of the casks must be of a high class to hold oil at all, and represents a cost equal to from one-third to one-fourth of the value of the oil carried. It will thus be seen that every consideration of safety demands carriage in bulk.

The great initial difficulty in the way of constructing such vessels, was the objection made to the single skin, on the question of classification. The Bureau Veritas Society, however, was satisfied that a vessel could be properly constructed to carry oil out to the skin, and encouraged that system, which now proves to be a success.

The s.s. *Glückauf*, is a steamer which has been built for this special trade to run between the petroleum ports of America (or the Black Sea) and Germany. She is the first of two sister ships built by Sir W. G. Armstrong, Mitchell & Co. The hold is divided by a middle-line longitudinal bulkhead, and further subdivided by thirteen transverse bulkheads; eight of these compartments are intended to carry oil. At the fore end there is a compartment for water-ballast, and water-ballast tanks are also fitted under the engines and boilers. At the fore part of the engine room there are two bulkheads, spaced 4 feet apart, intervening between the engines and the cargo. This compartment, or well, is for the purpose of receiving any oil which might leak from the cargo compartments or trunkways, and may be kept as an empty space, having provision by which it may be cleared of gas at any time by a steam jet. Each oil compartment is fitted with a trunkway, running up to the upper deck, forming a self-acting feeder to the main compartment as the temperature diminishes, and allowing the liquid to expand if its temperature should increase.

The *Glückauf* arrived on August 22, at Geestemünde, with her first cargo of best refined oil from New York. The oil was found to be in excellent condition in all respects, and gave the highest satisfaction. From the refinery at New York, the oil was run into the vessel at a temperature of 87° Fahr. On her arrival at the port of discharge, after sixteen days' voyage, the temperature was found to be reduced to 67° Fahr. The contraction of the oil due to this reduction of temperature was 0.86 per cent.

Figs. 1, 2 and 3, give longitudinal plan and midship section of s.s. *Glückauf*.

The arrangements of s.s. *Glückauf* are those patented by Mr. Henry F. Swan. Mr. Swan has also taken out a patent for another description of vessel, specially intended to carry a large amount of water-ballast, without its being necessary to utilize for this purpose any of the compartments intended for containing oil. If this were done by making the inner bottom flat, in the ordinary way, to contain a sufficient amount of water (say one-third of the vessel's cargo capacity), the result would be, that the center of gravity would be so low, that the vessel, when in ballast, would be a very bad sea-boat, and when laden with oil, the center of gravity, on the other hand, would be too high. To meet these points, Mr. Swan makes the inner bottom in an inclined form, as per section Fig. 4 or Fig. 5. Either form gives all the advantages of an ordinary double-bottom, but in many respects the form Fig. 4 is preferable, and it will be observed that unusual facility is given for repairs and examination, as a man can freely walk about in an upright position, instead of having to crawl through very irregular spaces as in the ordinary double-bottom, and which, if gas had accumulated, might become positively dangerous. (Figs. 6 and 7 give longitudinal section and plan of these vessels.)

In case the inner bottom has been utilized for carrying crude petroleum, or if, from any other cause, gas has accumulated, it can be entirely got rid of by simply pumping up the inner bottom, and continuing the pumping up the trunkways, which are opened to the upper deck, and which form a means of access to the interior of the vessel at all times.

The author may be allowed to say, that though it must be admitted it was a somewhat bold undertaking upon the part of the owners of the *Glückauf* to order this first vessel, yet the merit of her success rightly belongs to the eminent firm of shipbuilders in whose yard she was constructed.

The sister ship now building by Messrs. Armstrong, Mitchell & Co., is constructed on the same principle as the first. There is no cement in the bottom of these vessels in the way of oil, the oil filling the floor spaces.

Messrs. R. and W. Hawthorn, Leslie & Co., have now in course of construction two vessels for this particular trade, one of which is being built under the Bureau Veritas' special survey (Figs. 8, 9, 10 and 11).

These vessels are constructed with a double bottom, so that all the oil-tight work being done on straight and almost plain surfaces, in case of injury to the ship's bottom, the necessary repairs can be as easily executed as on an ordinary vessel. Fore and aft bulkheads are fitted throughout the oil compartments, and where there is only one bulkhead, a suction is fitted to either side to correct a list in loading or discharging.

In one design (Figs. 10 and 11), in order that two kinds of oil may be carried, the holds are divided amidships by a four-foot space, which also serves to carry up the trunks for access to the double bottom.

In the double bottom, transversely, there is a slight rise to cause a run to the suction, and to facilitate the clearing out of air and gas when the ballast is being run up, as the air-pipes are at the side on the highest part.

The expansion trunks are built on the deck. Perforated plates are fitted to prevent the oil moving in a body, and at the same time to allow it to expand into the hatch. Small air-pipes are fitted to the hatch covers; these may be closed when desired so as to give some control over the escaping gases.

The pumps on both these vessels are placed right for-

ward and on the tank-top, as it has been found difficult to lift petroleum any great height in hot weather, owing to the low tension of its vapor.

Fig. 12 shows the midship section of the ship *Andromeda*. This vessel was lately fitted with tanks in order to carry petroleum in bulk. She has made one or two voyages successfully, and delivered her cargo in good condition. This system does not (to the author's mind) compare favorably with that of carrying the oil out to the skin of the ship.

The author, in Fig. 13, submits to this Institution a plan of dealing with old vessels, to adapt them for the carriage of this liquid, which, he considers, will overcome some of the difficulties met with. The form of the ballast tank-top, he believes, is similar to the principle adopted by Mr. H. F. Swan. The sides of the oil compartment are made to form an inner skin to the ship, allowing a space between them and the skin to admit of easy access to all parts of tank for the erection or any necessary repairs. By adopting this plan, he thinks there will be a considerable saving in the first cost as compared with fitting tanks, and it will certainly make a far superior job as the carrying of the oil would entirely depend on new work, and further, the strength of the ship would be considerably increased.

Messrs. Boolds, Sharer & Co., of Sunderland, have recently built two small steamers for Russia (Figs. 14 and 15), fitted for the conveyance of oil in the bunkers as fuel for the ship's own use. The bunkers were fitted in part of the main hold, and also in the engine and boiler space; the bunker compartments extended to the skin of the ship, and were fitted on deck with manhole doors instead of hatches.

There can be no doubt that, for marine propulsion, and especially for ships of war, petroleum or mineral oil as fuel will be extensively used when more experience demonstrates its advantages as compared with coal, and the author looks to see tank-hulks established at coaling stations, and its use restricted only by the limited supply.

It may be interesting to the members to give an idea of the arrangements at Geestemünde for discharging and storing the oil. This is shown on Fig. 16. A flexible pipe is jointed to the ship's side and reaches to a pump driven by a gas engine on shore. The engine-house is marked A. The pump delivers into the circular tanks marked Nos. 1, 2 and 3. The combined capacity of these tanks is 4,900. The house marked G is the weighing-house, where railway tank-trucks are both filled and weighed. The railway trucks are like our ordinary tank-trucks, and hold about 12 tons of oil. The oil is sent in these trucks to the interior, or to any point in the railway system of the continent, and is then unloaded into tank-carts, holding each about a ton, from whence it is retailed into the tanks of storekeepers or private customers. It is not intended that the oil carried in bulk should be casked at all, although, of course, for special cases this may easily be done.

The Silber Car-Lamp.

THE following description of this lamp, taken from a London paper, would indicate that, if its merits are not overstated, it would be worthy of consideration by some of our American manufacturers and railroad managers:

The new roof lamp was shown in a model of a railway carriage, from which all other light was excluded; and the smallest type could be easily read in any part of the compartment by the light of one central lamp only. The flame is placed laterally beneath a reflector of iron, enameled white, and the glass under the flame is smaller than in many of the old-fashioned lamps, by which it is scarcely possible to read at all. Several hundreds of the new lamps are already in use on the Great Eastern and Great Northern railways, and both companies have given further orders for them; it having been found that their light is neither diminished nor rendered unsteady by even the most rapid traveling, that there is no overflow of oil into the glass, and that a lamp will burn for eighteen hours without attention. Taking the experience with the new lamps of the Great Northern Railway, as compared with the lamp used by the London & Northwestern, the performance of which was tested at the Society of Arts, it is found that the Silber lamp gives about four times the light at four-sevenths of the cost; and the quality of the light is shown by the fact that it will quickly produce photographic prints upon ordinary sensitive paper without the intervention of a lens. It, therefore, contains a large proportion of chemical rays, which testify to the completeness of the combustion by which it is afforded. The last improvement introduced by the inventor is to render the lamp capable of burning any oil, whether vegetable or mineral, light or heavy, without alteration in its arrangements.

The lamp is the invention of Mr. Silber, of Silber & Fleming, Wood street, E. C., London.

On the of Heat Combustion of Coal.*

BY SCHEURER KESTNER AND MEUNIER DOLLFUS.

[*Annales de Chimie et de Physique*, Vol. viii, p. 267, 1886.]

ABOUT the year 1870, the authors made experiments on the heat of combustion of coal, and drew attention to the circumstance that this cannot be calculated even approximately from its chemical composition. Dulong's formula, which makes allowance for the hydrogen, in the form of water, in coal, gives results too low; whilst if all the hydrogen is taken credit for, the results of calculation are sometimes below, and at others above those of experiment. In their previous experiments, the authors used the coal in the form of powder; in the present case, in small pieces, in which state the coal burns more easily in the calorimeter. The gases used (compounds of oxygen and nitrogen) to burn the coal were always carefully dried, and the cinders were weighed after combustion. The present results confirm those previously recorded.

The coals experimented upon were of the most various character, the carbon ranging from 96.66 to 76.87; the hydrogen from 5.1 to 1.35, and the oxygen, nitrogen and sulphur from 18.45 to 1.99 per cent. The authors give a complete table of the results of their experiments, and compare them with the heat of combustion according to Dulong's formula. The lowest result, 8,259 centigrade units (pure carbon being 8,080), was obtained from a coal having the largest proportion of carbon, 96.66; the lowest of hydrogen 1.35, and the lowest of oxygen, nitrogen and sulphur, 1.99; whilst the highest, 9,623, from one having 88.48 of carbon, 4.41 of hydrogen, and 7.11 of oxygen, nitrogen and sulphur. Only 9,193 units were obtained from a coal of the composition 89.96 carbon, 5.09 hydrogen, and 4.95 oxygen, nitrogen and sulphur, which, from its chemical analysis, would appear to be a superior coal to the previous one.

* Abstracts of Papers in Foreign Transactions and Periodicals. Minutes from Proceedings of the Institute of Civil Engineers.

Manufactures.

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 48.)

Chapter V.

THE ORGANIC DEVELOPMENT OF THE LOCOMOTIVE.

During the period of fifty years that has elapsed since Mr. Rogers first commenced to build locomotives in Paterson, not only has the machine as a whole been going through a process of evolution, as described in preceding chapters, but there has also been a development or adaptation of its various parts or organs, as they may be called, to the functions which they

Fig. 27.

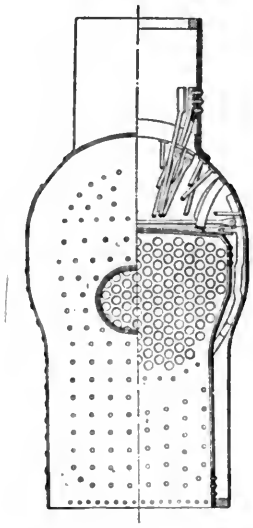
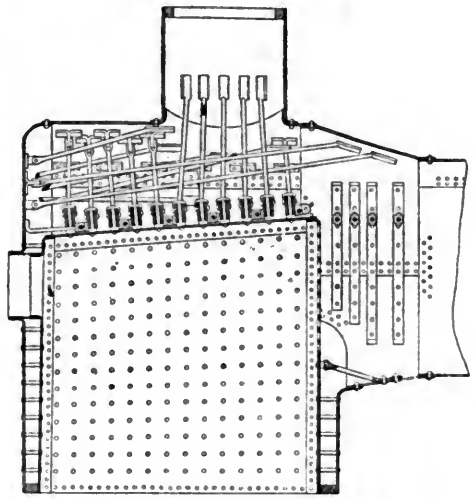


Fig. 28.



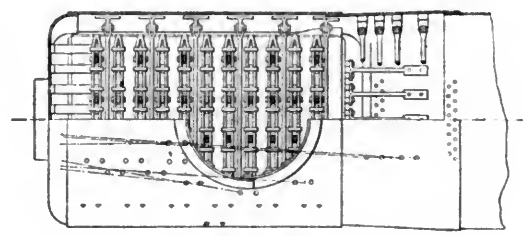


Fig. 29.

have to perform. A description of the different forms and methods of construction of these organs, which were adopted and in use at various times, will, therefore, become a sort of comparative anatomy of American locomotives. This may conveniently be divided into three parts—one relating to the boiler, another to the engines, and a third to the carriage or running-gear. These will be taken up in succession.

THE BOILER.

The boiler of the "Sandusky," the first engine built by Messrs. Rogers, Ketchum & Grosvenor, was substantially the same as that of the Stephenson engines, of what is known as the "Planet" class, that is, the top of the furnace was semi-cylindrical in form, and flush, or nearly flush, with the top of the barrel of the boiler. The horizontal section of the fire-box below the barrel of the boiler was square, or nearly so.

In 1837, Mr. Bury was made locomotive superintendent of the London & Birmingham Railway in England, which gave him an opportunity of adopting extensively on that line a class of engines, the original of which he introduced on the Liverpool & Manchester Railway in 1830. These were four-wheeled engines with inside cylinders, not unlike Stephenson's in their general plan, but the tops of the furnaces instead of being semi-cylindrical were hemispherical, and the horizontal section of the fire-box, below the waist of the boiler, was of a form approximating to the letter D, the flat part being in front. This form of fire-box was adopted in the fifth engine built at the Rogers Works, and it was in continuous use until 1857, and is shown in Figs. 14 to 22.

A large proportion of the early locomotives built in this country were built to burn wood. The Baltimore & Ohio Railroad was, perhaps, the only pioneer road that commenced by using coal for fuel, and even on that line many locomotives burned wood. As the weight of locomotives was increased and coal was substituted for wood, larger fire-boxes were required, and this led to the abandonment of the hemispherical-topped furnace, which was not well adapted to fire-boxes whose length was materially greater than their width, and the semi-cylindrical form which was first used, was substituted in its place. In these, the crown-sheets were usually stayed with crown-bars placed either lengthwise or crosswise on the top of the fire-box.

At first the cylindrical tops of the furnaces were made flush with the tops of the barrels of the boilers, but this form was succeeded by what is known as the "wagon-top" form of boiler, which was first used in the Rogers Works in 1850. The tops of the furnaces, in the boilers of this kind, were also semi-cylindrical, but they were made considerably higher than the barrels of the boilers, as shown in Figs. 23 to 26. The exact reason for first adopting this form of boiler is not known, but it had the advantage of giving more steam room, and allowed the use of more tubes and consequently more heating surface, than could be used in a flush-topped boiler. The wagon-top also gives more room for workmen on the inside of the boiler, over the crown sheets, and it thus facilitates construction and repairs. Mr. Hudson was always a strong advocate of this form, and he gave especial attention to staying it, as is shown in Figs. 27, 28 and 29, in which the stays and braces are shown.

For burning anthracite coal, it was found that very long fire-boxes were required. In 1860, the form shown in Figs. 30 and 31 was built at the Rogers Works from the design of Mr. Millholland, of the Philadelphia & Reading Railroad. The top of this furnace sloped downward from the barrel of the boiler, and the crown-sheet was stayed with screw-stays, excepting for a short distance behind the tube plate. Water grates were used in this fire-box, and are shown in the engraving.

In 1861, some fire-boxes with long combustion-chambers and a water bridge, as shown in Fig. 32, were constructed for the New Jersey Railroad & Transportation Company.

In 1862, a fire-box with the water leg A, Figs. 33 and

34, was made for the Chicago, Burlington & Quincy Railroad.

The brick arch, Figs. 35 and 36, was used in 1865.

In 1871, some engines were built for the Cumberland Valley Railroad, with the Buchanan fire-box, shown by Figs. 37 and 38.

The form of the Belpaire fire-box, shown by Figs. 39 and 40, was applied to locomotives for the Matanzas Railroad of Cuba, in 1874.

The Belpaire fire-box has been extensively used on the Continent of Europe, and within the past few years has been regarded with much favor by some of the leading master mechanics in this country, and it has been adopted on a number of railroads here.

The fire-box represented by Figs. 27, 28 and 29 is, however, the one which has been most commonly used for engines built at the Rogers Works. It has stood the test of long experience, and is still regarded with much favor by engineers and master mechanics.

tinually expanded and contracted, which caused them to leak. With a steam-gauge, however, a fireman had always a guide before him to indicate just what the steam pressure was, and could control his fire accordingly, and, therefore, was not obliged to open the furnace-door so often to regulate the steam pressure.

While the frequent expansion and contraction of the tubes probably caused them to leak, yet there can be no doubt that the methods of fastening them which were at first used were much less efficient than those which have since been adopted.

The manner of fastening tubes in 1837 is shown in Figs. 45, 46 and 47. The tube was inserted into the hole in the tube-plate, and a tapered mandrel, shown by Fig. 46, was driven into the end of the tube, so as to expand it to the full size of the hole in the plate. The mandrel was flattened on five sides, as shown in the end view, Fig. 47. After each blow on the end of the mandrel it was turned slightly so as to expand the tube equally all around. The end of the tube was then turned over, as shown in Fig. 45, which represents a longitudinal

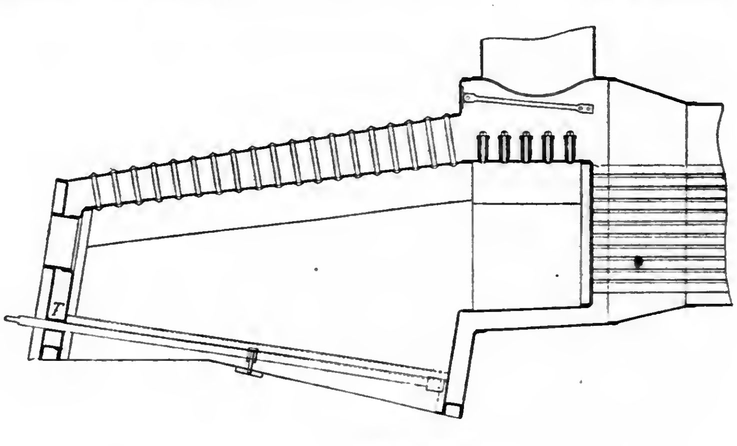


Fig. 30.

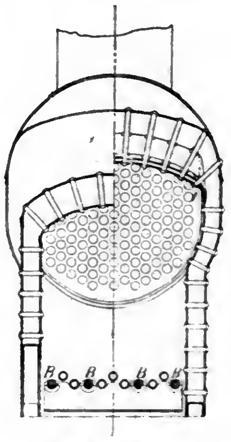


Fig. 31.

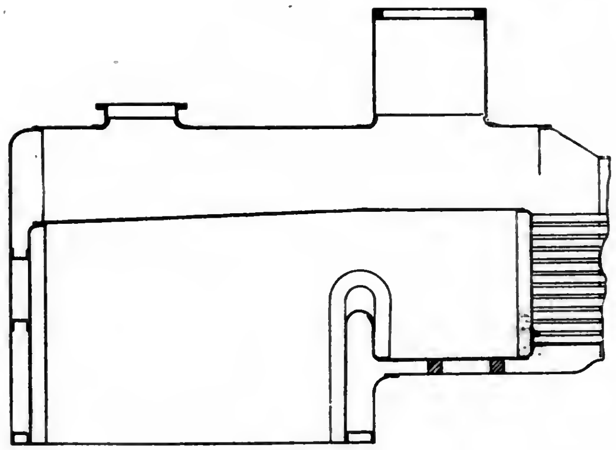


Fig. 32.

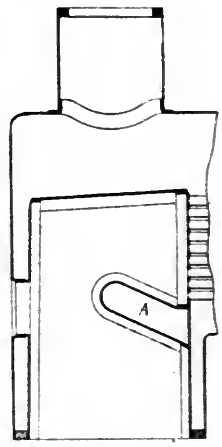


Fig. 33.

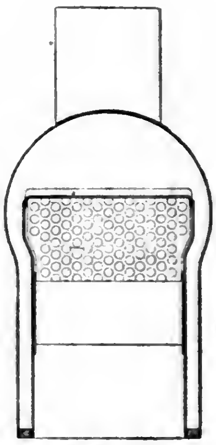


Fig. 34.

The form of brick arch shown in Figs. 41 and 42 was used in 1881. In this it will be seen that the fire-brick is supported on bent water tubes, which are attached at one end to the crown-sheet, and at the other to the front plate of the fire-box. Another form of brick arch supported on water-tubes, is shown in Figs. 43 and 44. This was used in 1885.

TUBES.

Very soon after coal was substituted for wood as fuel in locomotives, the use of copper and brass tubes was abandoned in this country, and iron tubes were used instead. At first there was a great deal of trouble in keeping these tubes from leaking. This was especially the case before steam gauges were generally used. Without these instruments it was impossible to tell what the steam pressure was, until the safety-valves commenced blowing off. They were, therefore, the principal guides by which the fireman was governed, that is, he would "fire" until "she commenced blowing off," and then he would open the furnace-door wide to cool the fire. The result was that the tubes were thus exposed to alternate currents of cold and hot air, and were thus con-

section of it. Probably some form of caulking tool was used for this purpose. A wrought-iron thimble, *T*, was then driven into the end of the tube.

In 1840, the form of caulking tool shown in Figs. 48 and 49 was adopted. This was inserted in the end of the tube with the notch *A* bearing against the edge, which was then turned over by driving the tool against it with a hammer.

As already stated, thirty or forty years ago, a great deal of trouble was experienced on locomotive engines with leaky flues. It was a constant source of annoyance, and every few days some one had to go into the furnace to hammer or caulk up the ends of the flues and thimbles (the flues at that time were either copper or brass, and the thimbles were of wrought-iron).

In 1850, Mr. Hudson, then master mechanic of the Attica & Buffalo Railroad, conceived the idea that if cast-iron thimbles were substituted for wrought-iron it would remedy this standing difficulty. Acting on this idea he proceeded to verify it—first, by taking a thimble of each kind, wrought and cast-iron, turning them accurately to a gauge, then heating them red hot, measuring them, and noting the expansion of each; afterward cooling them in water and again measuring

them. This process of heating, cooling and measuring was repeated twelve times, when the wrought thimble was found to be appreciably smaller in size than at first, and the cast-iron thimble larger. It was noticed that the former thimbles expanded more than the latter when red hot; this was anticipated.

To carry this idea into practice, a locomotive with leaky

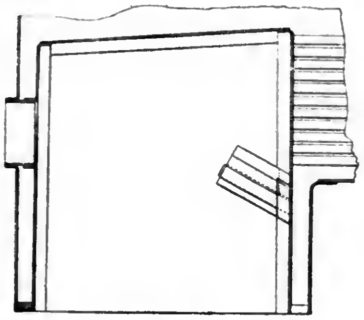


Fig. 35.

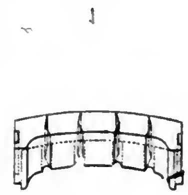


Fig. 36.

flues was taken; all the thimbles were taken out, the flues carefully expanded, and new thimbles put in. One-half or all on one side of the center line of the flue-sheet, vertically were of wrought-iron, and the other half were all of cast-iron. At the end of the first trip, when the boiler was cooling down, it was found that all the flues with wrought-iron thimbles were leaking, whereas, at the same time, all

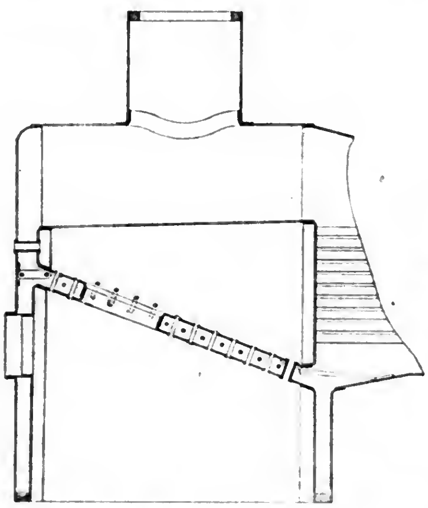


Fig. 37.

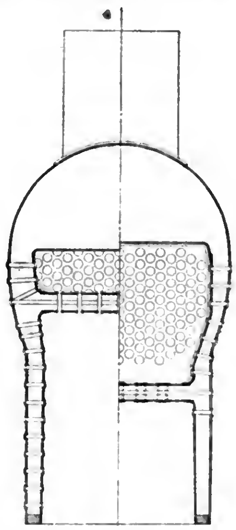


Fig. 38.

those opposite to them with cast-iron thimbles were tight. The wrought-iron thimbles were then taken out and cast-iron ones put in their places, when all stopped leaking, and so continued, the engine doing duty without any more trouble from leaky flues. The attention of Thomas Rogers was called to the fact, and he began to use the cast-iron thimbles with a like result. Mr. Rogers called the attention of

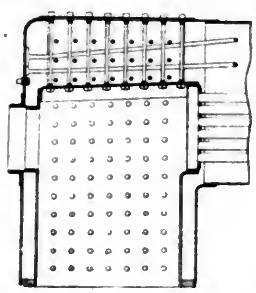


Fig. 39.

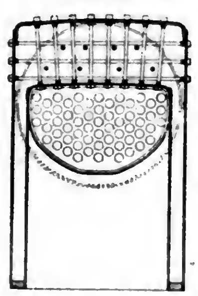


Fig. 40.

John Brandt, then in charge of the motive power of the Erie Railway, to the subject; he, also, immediately tried cast-iron thimbles, and found the result as stated above, and hence their use spread and became almost universal; few, except those who had experience in the matter at that time, can now realize how much annoyance and expense were saved by the change.

In 1861, tubes were fastened as shown in Fig. 50, that is, a copper end or thimble was brazed to the end of the tube, and a steel thimble was placed on the inside of it, so as to bring the copper between it and the tube-plate. The soft copper between the steel thimble and the plate, it was found, assisted materially in making and keeping the tubes tight.

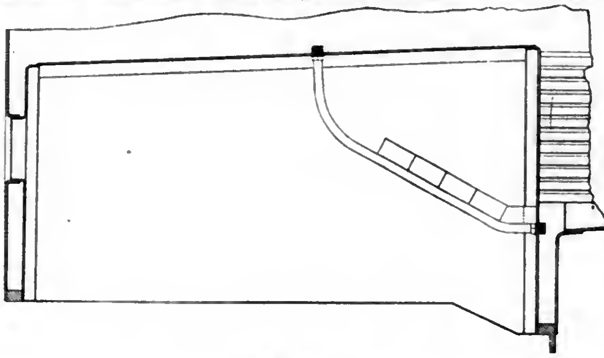


Fig. 41.

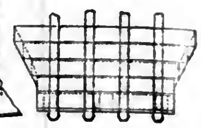


Fig. 42.

In 1862, the method shown in Fig. 51 was adopted. In this the copper end was dispensed with, and a copper thimble was placed on the end, outside of the tube, as shown.

The Prosser expander was first used at the Rogers Works in 1863. This is shown by Figs. 52 and 53. Fig. 52 is a side view with the end of the tube and plate shown in section at *A* and *A*. The expander consists of what may be called a plug composed of eight sector-shaped pieces, as shown in the end view, Fig. 53. These are held together by an open steel-spring ring *B*. In the center of the sectors there is a tapered hole *C*, Fig. 53 (shown by dotted lines in Fig. 52), into which a tapered plug, Fig. 54, is driven. The open spring-ring permits the sectors to separate when the tapered plug is driven into the opening. The sectors each have a shoulder

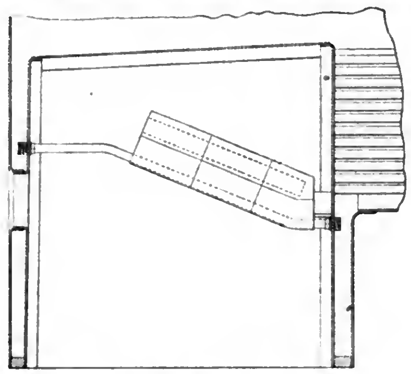


Fig. 43.

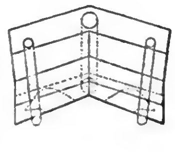


Fig. 44.

or projection at *S S*. These come just inside the tube-plate when the expander is inserted into the tube. By driving in the tapered plug or mandrel, Fig. 54, the sectors are forced apart, and expand the end of the tube. At the same

Fig. 45.

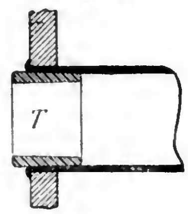


Fig. 46.

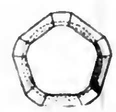


Fig. 47.

time the shoulders *S S* produce a ridge in the tube, inside of the plate, which helps to keep the joint tight.

In 1867, the Dudgeon expander, shown by Figs. 55 to 58, was introduced. This may be described as a hollow plug which has three rollers, *R R R*, Figs. 55 and 56, which are contained in cavities in the plug, in which they can revolve, and in which they can also move a short distance radially

Fig. 48.

Fig. 49.

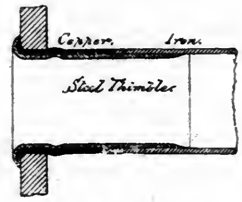


Fig. 50.

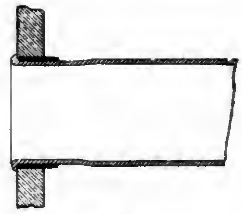


Fig. 51.

Fig. 54.

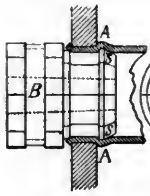


Fig. 52.

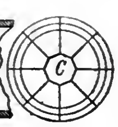


Fig. 53.

Fig. 58.

Fig. 57.

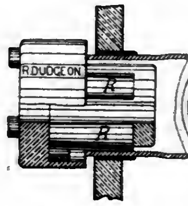


Fig. 55.

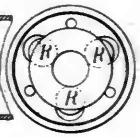


Fig. 56.

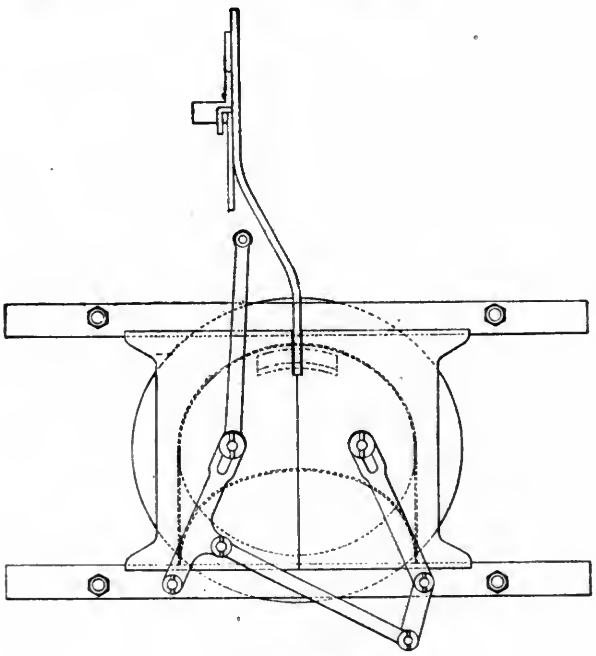


Fig. 59.

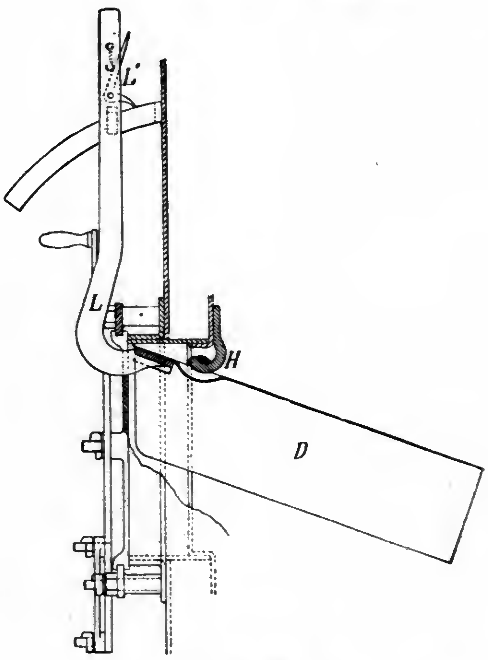


Fig. 60.

Fig. 61.

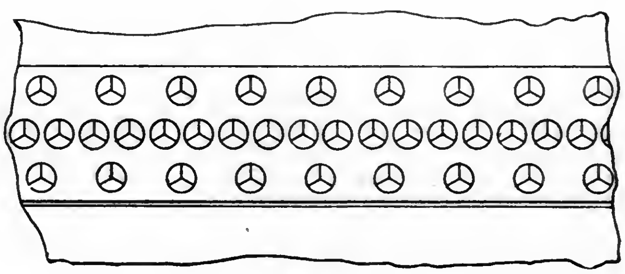


Fig. 26.

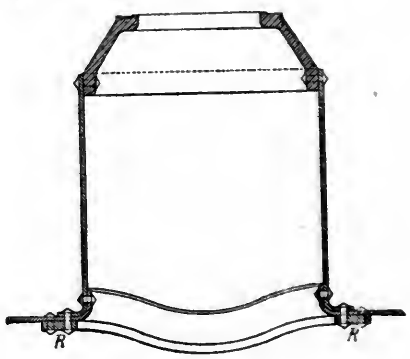


Fig. 63.

that is, from the center of the plug outwar'. When this expander is inserted in the end of a tube, a tapered mandrel, Fig. 57, is driven into the central opening, and it then bears against the rollers *R R*, and forces them outward against the tubes. A crank handle is then attached to the square end of the mandrel and it is turned around, which causes the ro lers to revolve on their own axes. This causes the hollow plug to revolve around its axis. The two thus have a sort of sun-and-planet motion in relation to each other. As the rollers bear hard against the tube their effect is to elongate it circumferentially, and thus enlarge it so as to completely fill the opening in the tube plate. Usually, copper ferrules are used outside of the ends of the tubes. This method is one which is now generally employed at the Rogers Works for fastening tubes in their plates.

FURNACE-DOOR.

In 1865, Mr. Hudson used the furnace-door deflector illustrated by Figs 59 and 60. *D* is the deflector which is suspended from a hook *H*, attached to the fire-box over the furnace-door. A lever *L*, is fastened to the deflector, by which it is moved out of the way when coal is thrown into the fire. The position of the deflector is regulated by the lever, and a latch *L* at its upper end. A pair of sliding-doors are used in connection with the deflector. These are opened by a system of levers, which are clearly shown in the engravings. This was suggested by a fireman in England, who found that, by inserting a scoop shovel upside down in the furnace-door, he could prevent smoke.

BOILER SHELLS.

In making boilers with iron-plates, Mr. Hudson always took great pains to have the plates of such sizes and proportions that the "grain" or fibers of the iron around the barrel of the boiler would be in the direction to resist the greatest strain. This practice is still continued in the Rogers Works when iron plates are used.

In 1852, he adopted the method of making the horizontal seams of boilers shown by Figs. 61 and 62. This consisted of an ordinary single-riveted lap seam, with a covering strip or "welt" over the inside, which was made wide enough to take an extra row of rivets on each side of the main row. The outside rows were spaced double the distance apart of those in the main row. The welts not only serve to strengthen the seams, but they cover the inside caulking edges where corrosion and "grooving" or "channeling," as it is called, is most likely to occur. By being covered, these edges are protected from the action of the water.

DOMES.

The first method of fastening domes, as shown in the engraving of the "Sandusky," Fig. 12, was to rivet a circular casting, having a flange top and bottom, to the barrel of the boiler. The upper part of the dome was also made of cast-iron and was bolted to the top flange of the circular casting. A similar plan was also adopted when the domes were attached to the tops of the hemispherical-shaped furnaces, as shown in Figs. 12 to 22. Even after the use of the hemispherical-shaped furnace was abandoned, cast-iron domes were still used, and, in some cases, the bases of the domes were made of wrought-iron. When the size of engines and their domes was increased so much that is became impracticable and unsafe to make them of cast-iron, they were made of wrought-iron plates, with a flange at the bottom, which was riveted to the boiler shell, as shown in Fig. 30. Later, the boiler shell was flanged upward around the edge of the opening at the base of the dome, as shown in Figs. 26 and 27, in order to give additional strength at this point. The dome was then attached to the boiler with two rows of rivets. In 1880, a reinforcing ring, *R R*, was added at the base of the dome, as shown in Fig. 63. This serves to strengthen the boiler shell at the base of the dome, where it is weakened by the opening required to give access to the inside of the boiler.

(*To be continued*).

Brick Pavements.

WITHIN the past few years several towns in the Western States have been experimenting with street pavements of brick. Many miles of brick pavement, it is needless to say, exist in Holland, and, if we are not mistaken, there are remains of brick in the streets of Nantucket; but elsewhere in the United States this material has been rarely, if ever before, used for the purpose. According to the *Engineering News*, Bloomington deserves the credit of being the first modern town in the country to introduce brick paving on an extensive scale. The town is situated in the clay region, and bricks are cheap there, as well as good; and, by careful selection of material, it has been found possible to produce bricks so tough and hard that in Bloomington, where seven miles of streets are now laid with them, they have been found, after ten years' experience, durable, as well as cheap and convenient. In Amsterdam, where, although canals intersect the city in all directions, a good deal of traffic is carried on by means of horses and wagons, the pavements of small, whitish bricks show little sign of wear; and, partly on account of their porosity, and partly from the numerous joints which exist between them, they are in wet weather much dryer and pleasanter to walk over than stone, or even asphalt. In the Illinois towns, the streets are prepared for paving by forming natural surface into the proper profile; on this is then laid four inches of coarse sand or cinders, evenly spread, cinders being preferred on account of the better drainage which they afford, and the whole is covered with bricks laid flat, with joints as close as possible, and accurately formed to the desired profile. Fine sand is then spread over the surface, and worked well into the joints with a broom, and, after laying an inch more of sand over it, the top course, consisting of brickson edge, is set as closely as possible, and the joints of this also well filled with sand. The multiplicity of joints makes the pavement easy and safe for horses to travel over, and the whole cost is only from $1.40 to $1.80 per square yard.—*American Architect.*

[About ten years ago, Ross Winans, of Baltimore, laid the block adjoining his house in that city with a brick pavement, but we have no knowledge of the success of the experiment. Perhaps some reader in that city can give a report of the results.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

Pressure and Composition of Natural Gas.

IN a paper on this subject, read before the Engineers' Club, of Philadelphia, Dr. H. M. Chance, the author, says: "We have no records of the gas pressure first shown by the largest wells. The recorded pressures have nearly all been observed after the gas had been blowing off for some weeks, or months, or even years: and the pressure then shown by a gauge is evidently no measure of the pressure under which the gas exists in the rock, for the gas soon becomes exhausted from the immediate vicinity of the well, which then draws its supply from a considerable distance, and perhaps, through bands of rock of such texture (and perhaps, even through the clay filling of crevices) that the pressure shown at the well may be only a fraction of the actual pressure. Hence, while recorded pressures range from about 600 down to 200 pounds per square inch, we have every reason to believe that the actual pressures are, perhaps, from 500 to 1,000 pounds per square inch, or even, in some cases, much greater, but must still be less than the maximum as limited by depth. I have shown that this maximum is very much less than the pressure necessary to effect liquefaction, and we must abandon the supposition that the gas exists as a liquid.

"One of the most interesting phenomena recently observed in natural gas is its variability. The analysis of Prof. Sadler,* made some nine years ago, told us that gas from wells located in districts not connected with each other was similar in composition, but that the percentages of the different gases present varied widely. We were, however, not prepared for the discovery that gas from wells in the same "pool," and that from the same well, was subject to daily and even hourly variations in composition. When it was found that the calorific value of the fuel was subject to change, from time to time, as shown by variations in temperature of the furnaces, and in the steam pressure of boilers under which it was burnt, this was at first supposed to be due to differences in pressure, that is, in the quantity of gas delivered to the burners in the fire-box. Automatic pressure-regulators were introduced, and the producing companies perfected a system by which the pressures were maintained at a nearly constant figure, yet the same variations were observed. The chemists then began to examine the gas and some found that it was extremely variable in composition."

* Report L, Pennsylvania Geological Survey.

New Inventions.

The Whitney Contracting Chill for Casting Car-Wheels.

It is a well-known fact that in casting a railroad car-wheel, that part of the mould which forms the tread and flange of this wheel consists of an iron ring. It is called technically "the chill" or chill mold, because it suddenly cools or chills the molten iron used to cast the wheel, and thus produces a hard wearing surface of white iron on the tread. This "chill" heretofore has been simply a cast-iron ring of suitable thickness, turned out on its inner surface to the shape of the tread and flange of the wheel. Recently, however, what appears to be an improvement on its construction has been made by the well-known firm of A. Whitney & Sons, of Philadelphia. The improvement was first suggested many years ago by their Superintendent, Mr. L. R. Faught, the main idea at first being to prevent the disintegrating of the inner surface of the chill by sawing its face into many sections. A wheel cast in such a chill was part of their exhibit at the Centennial Exhibition in 1876. This led to many experiments with different forms of chills, both in their own shops and in the shops of the Pennsylvania Railroad Company at Altoona, under the superintendence of Mr. J. N. Barr, who at last obtained satisfactory results, and secured Letters Patent for his improvements. During 1885 Messrs. Whitney & Sons resumed their experiments, and, after very careful researches into the causes of previous failures, at last perfected their present device that their senior partner, Mr. John R. Whitney, has covered by several Letters Patent. The principles and construction of the chill known as the Whitney contracting chill, are so fully and clearly set forth in the patent specifications that we cannot do better than to quote directly from them, as follows:

Ordinary car-wheel chills as heretofore made have consisted of solid rings of metal of about one inch and a half in thickness, and sometime more, and provided upon opposite sides with trunnions or handles. At other times, the chills have consisted of rings to which are bolted an inner facing or lining composed of separate pieces in close proximity. In other cases, the chill has consisted of a hollow ring with radial and vertical sections, which are made to expand and contract by alternate currents of steam and water through the hollow ring.

In the ordinary chills above named, the parts constituting the chilling-surface are of different thicknesses at different points in the circumference, and, owing to this and other features of the construction, the density of the metal varies at different points of the chilling-surface. Thus in a chill an inch and a half in thickness, the central portion is always much more open than the outer edges, and this inequality of texture is increased at intervals wherever there are projections, such as are formed by the trunnions and lugs. As a consequence, when the molten metal is poured into the mold, the chill does not expand equally at all points, and so remains in contact with the wheel longer at some points than at others, and thus produces a deeper chill wherever the contact is most prolonged. This effect is increased if the flask is out of level or the chill is unequally exposed to currents of air, etc. This unequal and irregular expansion of the chill is very apt to result in permanently altering its original shape, so that the wheels produced in it after a time become more or less out of round. As the inner surface of the ring is first heated and tends to expand before the outer portion can yield, the inner surface also soon becomes disintegrated and loses its original smoothness of finish.

Another difficulty resulting from the employment of chills of the ordinary construction ensues from the fact that if the molten metal is of a soft, fluid, low-chilling character it retains its heat much longer than when harder and chilling well. It thus expands the chill to a much larger size before the inclosed wheel becomes solid, and, as a consequence, wheels made from metals of different tempers, even if cast in chills of the same diameter, when cold, will be found to vary in their circumference.

All these difficulties are overcome, partly by the use of a chill of a particular form and partly by constructing the chill, whatever may be its form, so that all parts of the chilling-surface shall be of the same or nearly the same density, for the inventor has discovered that when the chilling-surface is of uniform or nearly uniform density the chill produced is more likely to be of uniform depth, and this discovery has enabled him to secure uniform results by a proper construction of the chill.

One means of making the chill so as to secure the uniform or nearly uniform density of the chilling-surface consists in constructing it of parts substantially uniform and not exceeding one inch in thickness, and preferably very much less, so that when cast there will be no undue strains, tending to condense some parts more than others. Thus, instead of making the chill in the form of a ring of one inch and a half or more in thickness, and with projections at some portion, it is constructed with two rings, A B, Fig. 1, each of about five-eighths or three-fourths of an inch in thickness, connected by webs, the inner ring, B, being of uniform thickness throughout its entire extent, while the webs *c*, which connect the inner to the outer ring, are no thicker than the inner ring. This uniformity in the thickness of the rings and webs insures a practical uniformity of density in the chilling-

Fig. 1.

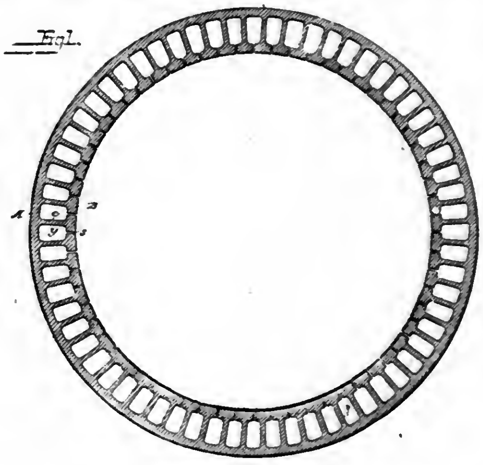
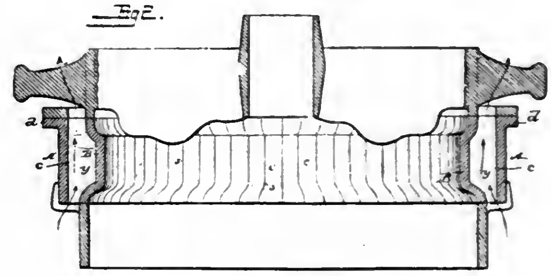


Fig. 2.



THE WHITNEY CONTRACTING CHILL.

surface of the ring B. The outer ring A, is preferably made of the same thickness and entirely without trunnions or lugs, so that when the chill is heated all the parts will expand simultaneously and regularly.

To increase the efficiency of the inner ring B, it is separated into sections by narrow slots or kerfs *s*, extending radially into the openings *y* between the webs *c*, so that each section is free to expand when heated by the molten metal of the inclosed wheel without its surface being compressed, while the expansion of all the sections and their supporting-webs causes the contraction of the inner diameter of the chill and keeps the chilling-surface in close and equal contact with the wheel at all points as long as the chilling effects are needed. While the inner ring is thus kept in contact with the wheel the outer ring can be maintained in a nearly cool condition, so as to maintain the general shape and dimensions of the chill, by the natural passage of air through the openings *y* across the narrow webs *c*, the chill projecting beyond the cope and drag, so that the air can flow freely to and upward through and from said openings outside of the cope and drag.

Fig. 1

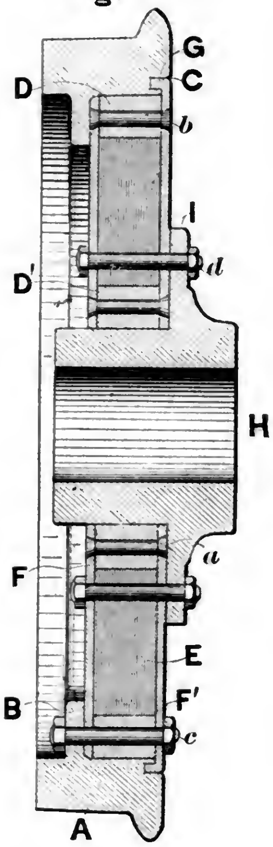


Fig. 2

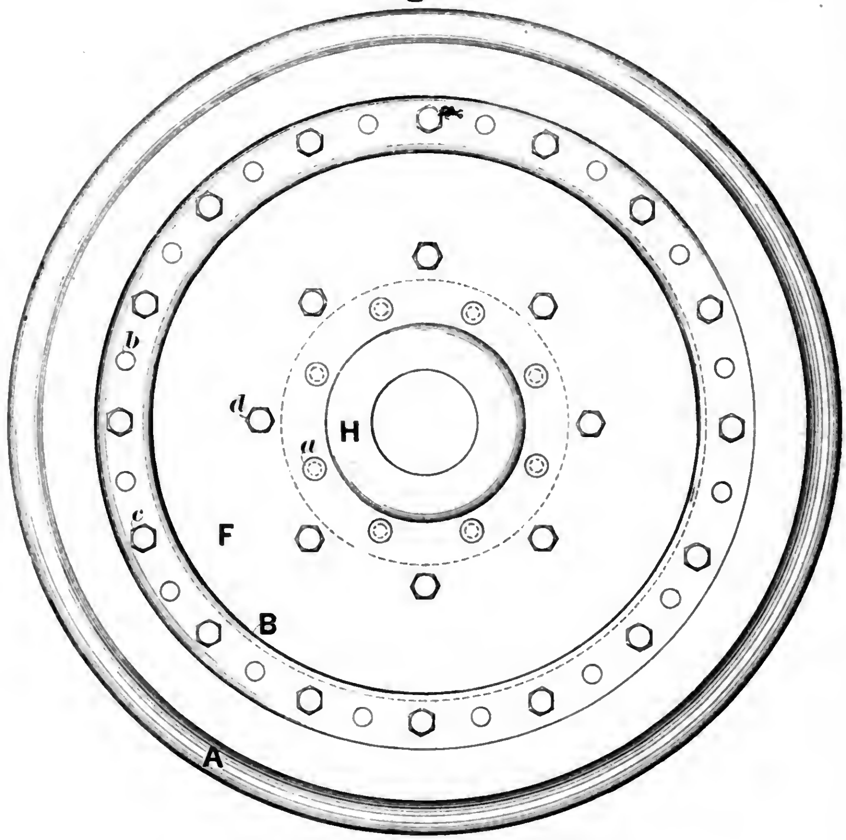


Fig. 3

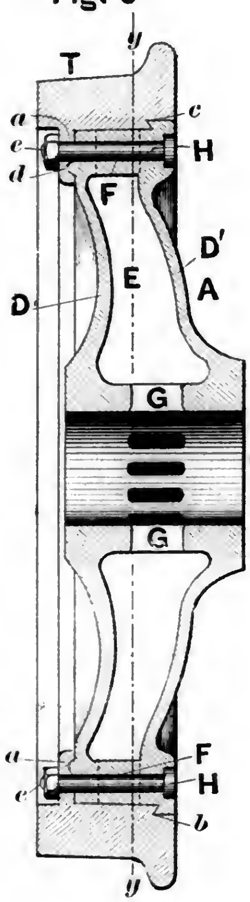
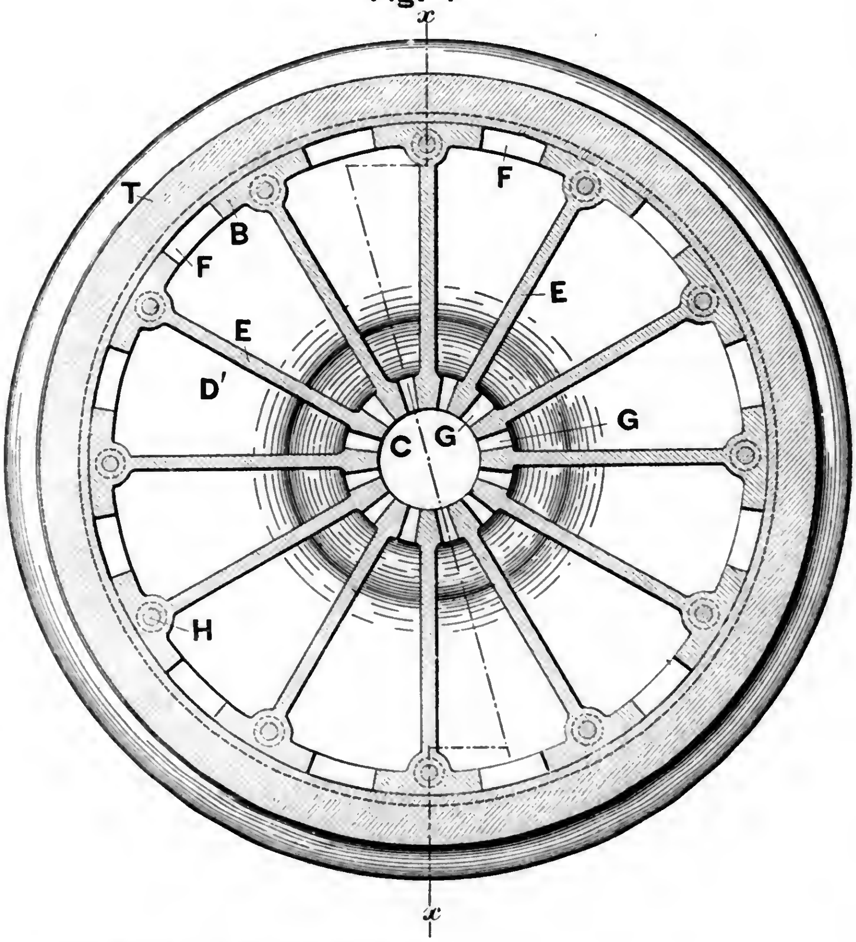


Fig. 4



ALLEN'S IMPROVED CAR-WHEELS.

Heretofore, when the inner face of the chill has been divided by radial slots, the latter have been made by means of saws or other thin cutting-tools. This involved great expense of tools and labor, and required that the sections should be comparatively thin at the points where thus cut, but, being thinner at these points than at others, produced a chilling-surface of varying thickness. The inventor, however, has discovered that the chill may be made complete with the slits between the sections by arranging thin sheets of asbestus in the mold, so as to separate the metal in the process of casting, the asbestus forming cores much thinner than the smallest kerf that can be cut by saws or other tools available for such purposes, or that can be made by strips of iron or other materials used as cores. By this means, he is enabled to separate the sections by spaces not exexceeding one one-hundredth part of an inch in width if required, thus allowing room for the requisite expansion of the sections and consequent contraction of the chill, and yet preventing the irregularities in the casting otherwise resulting.

When the molten metal is brought in contact with the *ordinary* chill, it is found that it begins to heat the same and expand it; but as soon as the metal solidifies it also itself expands, so as to remain in contact with the chill, until the solidification of the surface is complete, after which it immediately begins to contract, while the chill itself, if constructed as usual, continues to expand. If the chill is constructed in the ordinary manner, a constantly-increasing separation between the wheel and the chill thus takes place. But in the construction of the chill above described the outer ring A, remains cold and does not expand; but the heating of the ring B and the webs *c* causes the expansion of these parts, and the sections of the ring are moved inward, thus maintaining the chilling-surface in contact with the metal until the latter has become thoroughly hardened and deeply chilled. The chill thus constructed may be used in connection with the sprinkling apparatus shown in Letters Patent No. 258,182, whereby the effects above described are much increased; but whether the sprinkling apparatus be used or the natural draft of the air alone be depended upon for keeping the outer ring of the chill at a low temperature, the effect is to produce wheels of substantially uniform circumference regardless of the temper of the metal, inasmuch as the variations in the length of time with which the metal is in contact with the chilling-surface can have no effect in changing the size of the outer ring, which serves as a fixed abutment, from which the sections of the ring may expand, and thus contract the inner diameter of the chill.

In order to permit the chill to be readily lifted, it is preferable to provide the outer ring with a flange, *d*, Fig. 2, which extends completely around the periphery, but which does not materially affect the density of the chilling-surface of the inner ring or section of the chill. This flange serves as a means of seizing the chill by the grapples when it has to be moved, and has the further advantage of permitting the chill to be easily rolled from place to place, which cannot be done when it is provided with trunnions.

These chills are so constructed that the heat of the molten metal causes them to contract, instead of expand. This contraction is simultaneous and uniform at all points of the chilling surface. They thus remain in constant and close contact with every part of the tread of the wheels until the full chilling effect required is produced. The depth of chill thus secured does not vary materially in the whole circumference of the wheels; the wheels are practically as round as turned steel or wrought-iron tires and chills that have been in almost daily use for six months are found to retain accurately their original shape and size. Messrs. Whitney & Sons are thus enabled to produce wheels which they claim are greatly superior to any made in the ordinary way, especially in the following important particulars, viz.: Accurate roundness; uniformity of size; increased depth of chill; uniformity in depth of chill; greater density and durability of chill; and hence, an increased mileage under similar circumstances.

In order to still further meet the growing demands of railway service for an increase of strength and durability in wheels, we are informed that they have also, during the last year, made very important changes in the form of many of their patterns, and in their mixture of irons. In May, 1885, they ceased entirely to use steel, and their mixture now consists of charcoal irons, carefully selected because of their superior strength and chilling properties. They will guarantee that wheels made of such materials, and by their improved process, will give 25 per cent. more mileage than any wheels made in the ordinary manner and used under the same conditions.

Allen's Improved Car-Wheels.

THE engravings herewith represent two forms of car-wheels which have been patented by Mr. Richard N. Allen, and have recently been brought out by the Allen Paper Car-Wheel Company.

Figs. 1 and 2 represent an improvement in the well-known paper car-wheel which is so extensively used in this country. Fig. 1 is a section and Fig. 2 an outside view of the wheel. The improvement consists in the introduction of two wrought-iron or steel rings D and D′, in connection with a compressed paper core or disk E, which form the body or "center," as it is technically called, of the wheel. The core is enclosed between two wrought-iron or steel plates F and F′, which are fastened together by rivets *b* and *a* which pass through the plates and metal rings D and D′.

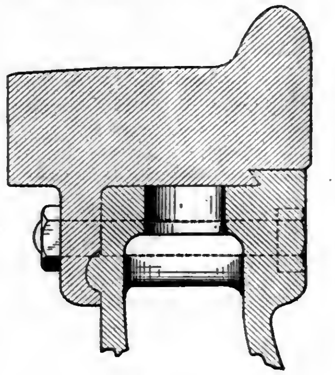


Fig. 5.

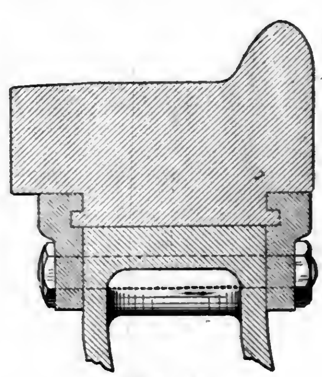


Fig. 6.

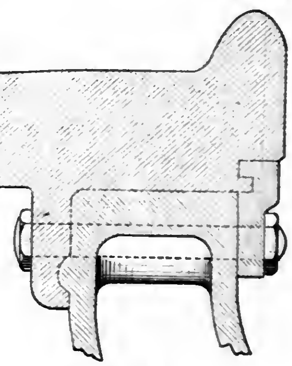


Fig. 7.

H is a cast-iron hub with a flange, I, on the inside, large enough to overlap the plate F′ and the ring D′. The latter and the hub are accurately bored and turned, and after the core E, plates F and F′ and the rings D and D′ are all fastened together by the rivets, the wheel center is forced on the hub and bolted to it by bolts *d*, which pass through the flange I, plates F F, and core E. The tire G′ is then fixed on the ring D and bolted to it by bolts *c*, which pass through the flange B, the plates F F′ and ring D.

The plate F′ is provided with a flange or tongue C which fits into a corresponding groove in the tire which helps to hold the latter in its place in case of a breakage.

The object of the rings D and D′ is to strengthen the wheel center, and also to form bearings for the tire and hub which will resist without injury the friction incident to forcing them on and off of the wheel center. With these rings either the tire or the hub, or both, may be removed as many times as may be necessary, and their peripheries

or bearings will still remain in good condition to receive new tires or hubs.

Mr. Allen has also patented a steel-tired wheel shown by Figs. 3 and 4, the center of which is made of cast-iron or steel. Fig. 3 is a section on line *x x* of Fig. 4 or on the axis of the wheel, and Fig. 4 a section on the line *y y*, of Fig. 3.

The wheel center consists of a casting composed of two curved plates D and D′ united by radial webs or ribs E E, cast in the form of spokes. The spaces between the plates and the radial webs are cored out in a manner which will be obvious to any practical person.

The tire may be fastened on the wheel in any practicable way, as shown in Fig. 3 and on an enlarged scale by Fig. 5, or as shown in Figs. 6 and 7. Any of these methods will hold the tire to the wheel in case the tire breaks. With reference to cast-iron centers, it may be said that if they are safe for locomotive wheels of double the diameter and carrying twice the loads that car-wheels must bear, they surely should be safe under cars, if the tires are properly secured, so as to guard against accident in case of their breakage.

Both of the kinds of wheels illustrated above are manufactured by the Allen Paper Car-Wheel Company, of 239 Broadway, New York.

Proceedings of Societies.

Master Car-Builders' Brake Committee.

A joint meeting of the M. C. B. Brake Committee and the representatives of brake companies intending to participate in the April, 1887, tests, will be held at Pittsburgh, at 10 o'clock A. M., Wednesday, Feb. 9, at the Hotel Anderson.

The rules governing the tests will be decided on at this meeting. A full attendance is requested.

Boston Society of Civil Engineers.

A regular meeting of this Society was held in Boston, January 19, Vice-President L. F. Rice in the chair.

Mr. George W. Blodgett read a paper on the Steam Engine and Electric Lighting.

Mr. L. F. Rice read a paper on some problems in construction met with in practice, treating at some length on the Green River Bridge on the Troy & Greenfield Railroad.

Engineers' Club, of Philadelphia.

THE annual meeting was held at the Club House, No. 1122 Girard street, Philadelphia, on January 8th. President Washington Jones occupied the chair; 40 members were present.

The retiring President, Mr. Washington Jones, read the annual address. In it he gave a brief account of the most prominent engineering works projected, in progress and completed, abroad and in the United States. The importance of railroads to the people was dwelt upon; their bridges, tunnels, locomotives, etc., and the miles of track laid during 1886, were referred to. Street railroads, and the manner of moving their cars, elevated railroads and subway roads were compared and their qualities noted. New water works, especially those projected for the City of Philadelphia were noted, and extracts from Mr. Rudolph Herring's report on his surveys of water sheds, forming sources of supply other than that of the Schuylkill River, were quoted; also a description of the intercepting sewer (furnished by the courtesy of the Chief Engineer of the City of Philadelphia), intended to carry the sewage of Manayunk and discharge it below the pool at Fairmount. The quantities of minerals mined in the United States during several past years were noted and allusion was made to the Bartholdi Statue of Liberty. The concluding portion of the address was devoted to remarks upon the satisfactory condition of the Club, the convenience of its quarters and location, and the desirability of an increased number of papers upon professional matters.

The Secretary and Treasurer presented his annual report, showing total receipts of $4,144; expenses were $3,779, leaving a balance of $365. Besides its library and furniture the Club has assets amounting to $1,018. At the close of 1886, the Club had 3 honorary, 5 corresponding, 451 active and 9 associate members; a net increase of 28 active members.

The tellers reported the following officers elected for the ensuing year: President, Thomas M. Cleeman; Vice-President, Joseph M. Wilson; Secretary and Treasurer, Howard Murphy; Directors, John T. Boyd, C. W. Buchholz, Frederick Graff, Washington Jones and M. R. Mucklé, Jr.

President-elect Cleeman then made a brief and appropriate address.

After routine business had been disposed of, Mr. Henry R. Cornelius read a paper relating to the two large centrifugal pumps at Mare Island Navy Yard, California, built by the Southwark Foundry & Machine Company.

The pumps, the dimensions of which are 42-inch discharge pipes and 66-inch runners, are each driven direct by a vertical engine 28 inches diameter and 24 inches stroke, and were designed to remove the water from a dock 529 feet long, 122 feet wide and 36 feet deep, with a capacity of 9,000,000 gallons.

After being erected on foundations prepared by the Government, a test trial was made by a Naval Board, the following being extracts from their report:

"At the final trial of the two pumps together, the water was admitted to the 23d altar, the dock containing 7,317,779 gallons, being 7 feet above the center of the pumps. * *

"During a pumping period of 55 minutes the dock had been emptied from the 23d to 2 inches above the 6th altar, containing 6,210,698 gallons, an average throughout of 112,922 gallons per minute. At one time, when the revolutions were increased to 160 per minute, the discharge was 137,797 gallons per minute. This is almost a river, and is hardly conceivable.

"The engines worked noiselessly and without shock or labor. At no time during the trial was the throttle-valve open more than ⅜ inch.

"The indicator cards taken at various intervals gave 796 horse-power, and the revolutions did not exceed 160 at any time, though it was estimated that 900 horse-power and 210 revolutions would be necessary to attain the requisite delivery."

The reading of other papers was deferred to the next meeting, and the Club adjourned.

Engineers' Society of Western Pennsylvania.

This Society held its seventh annual meeting in Pittsburgh, on the evening of January 18. It was first organized seven years ago with 32 members; there are now 306 on the roll.

The President made his annual address, which was a general review of the work done by the Society during its seven years of existence, following by a brief outline of the scientific history of the year just closed.

The Treasurer's report showed that the total receipts for the year were $1,154, and the expenditures $981. There is now $306 in the treasury, and the library fund amounts to $120. The Library Committee reported the addition of a new book-case filled with valuable technical works.

A minute was adopted on the death of Thomas M. Carnegie, an active member of the Society.

The following officers were elected for the ensuing year: President, Alexander Dempster; First Vice-President, J. A. Brashear; Second Vice-President, M. L. Becker; Directors, A. E. Hunt, William Miller; Secretary, S. M. Wickersham; Treasurer, A. E. Frost. The meeting then adourned.

Engineers' Club, of St. Louis.

This Club met in St. Louis, January 19, President Polter in the chair; 26 members and 6 visitors present. A number of applications for membership were received.

The Secretary reported having prepared an engrossed copy of the memoir on C. Shaler Smith as directed at the last meeting.

The special order of the day, a paper by H. S. Pritchett on Mexican Longitude Determinations, was then taken up. The Club then adjourned to a room specially prepared for the occasion. By the aid of the magic lantern the paper was fully illustrated. A complete description of the apparatus used, the method of making the observations and of computing the results were explained and the results were compared with those previously obtained by other methods. The author showed a number of views of Mexican scenery and points of interest, with some remarks on peculiar features of the country and the characteristics of its people.

The Club then adjourned to visit the time department of Washington University.

PERSONALS.

Mr. J. F. Wallace has been appointed Chief Engineer of the Peoria Terminal Railroad at Peoria, Ill.

Mr. John T. McNeil has been appointed State Inspector of Coal Mines of Colorado for another term.

Mr. John B. Yates is Chief Engineer of the Zanesville, Mt. Vernon & Marion, a new line which is to run from Zanesville, O., to Marion.

Mr. Ferdinand Hall has been appointed Chief Engineer of the Louisville, New Albany & Chicago road, and will have his office in Chicago.

Mr. J. F. Hinckley has been appointed Chief Engineer of the St. Louis, Arkansas & Texas road, and will have his headquarters at Texarkana, Texas.

Capt. Francis V. Greene, United States Engineers, has resigned his commission to take the position of Vice-President of the Barber Asphalt Company, of New York and Washington.

Mr. C. Breckenridge, of Covington, Ky., has been engaged to make a preliminary survey for the projected Tennessee Midland road, from Knoxville, Tenn., through Nashville to Memphis.

Mr. J. B. Barnes has been appointed Superintendent of Motive Power, and M. M. Martin Superintendent of Car Department, for the Wabash, St. Louis & Pacific lines east of the Mississippi River.

Col. Charles E. Blunt, United States Engineeers, was placed on the retired list January 10, on account of age. Col. Blunt graduated from West Point, 1846, and has served in the army for 40 years.

Mr. George W. Cope, for two years past Secretary of the American Iron & Steel Association, has resigned that office, and accepted the position of Western editor of the *Iron Age*, with office in Chicago.

Professor Samuel P. Langley, of the Allegheny Observatory at Pittsburgh, has received from the Royal Society, London, England, the Rumford gold medal for "meritorous discoveries in light and heat."

Mr. W. W. Rich has been appointed Chief Engineer of the Minneapolis & Pacific, with office in Minneapolis, Minn. He retains his position as Chief Engineer of the Minneapolis, Sault Ste. Marie & Atlantic also.

Mr. W. H. Peddle, under the new organization of the Central Railroad of New Jersey, will be Engineer of the New Jersey Central and the New Jersey Southern divisions, and Mr. J. H. Thompson is Engineer of the Lehigh & Susquehanna Division.

Mr. I. C. Brewer, recently Division Engineer on the Lake Shore & Michigan Southern road, has resigned his position and gone to Chattanooga, Tenn. He will have charge of the construction of several branch lines for the East Tennessee, Virginia & Georgia road.

Prof. R. H. Richards, President of the American Institute of Mining Engineers, sailed from New York for Bermuda, early in January. Prof. Richards' health is much improved, but it is doubtful whether he will be able to attend the February meeting of the Institute.

Mr. Louis Caldwell is to have charge of the survey of the Louisville, Cloverport & Western, a new line projected to run along the south side of the Ohio River from Louisville to Henderson, Ky. Mr. Caldwell has been recently Superintendent of the Louisville & Portland Canal.

Mr. R. H. Elliott is Chief Engineer of the new Kansas City, Memphis & Birmingham road, succeeding Mr. John A. Grant, who goes to the Texas & Pacific as General Manager. Mr. Elliott has been for some time Assistant Chief Engineer of the Louisville, New Orleans & Texas road.

Mr. William G. Raoul retired from the position of President of the Central Railroad Company of Georgia at the annual meeting in January. He had been connected with the road for 15 years, serving successively as Roadmaster, Assistant Superintendent, Superintendent and Vice-President until 1883, when he was chosen President in place of the late William Wadley.

Mr. A. A. McLeod, who succeeds Mr. John E. Wootten as General Manager of the Philadelphia & Reading road, was for several years General Manager of the Elmira, Cortland & Northern road in New York. He went to the Reading road last year as Assistant to the President, and was made Acting General Manager when Mr. Wootten retired on account of ill health.

Gen. E. P. Alexander, who succeeds Mr. W. G. Raoul as President of the Central Railroad of Georgia, has had a somewhat varied experience. He is a graduate of West Point, and served several years in the United States Engineer Corps. During the war he served in the Confederate Army, and was for some time Chief of Artillery, under Gen. Lee. After the war he was successively General Superintendent of the Charlotte, Columbia & Augusta, General Manager of the Western Railroad of Alabama, President of the Georgia Railroad and First Vice-President of the Louisville & Nashville. He left the last-named road four years ago, and has since been chiefly employed as a consulting engineer.

Mr. Arthur M. Wellington has become editor and part proprietor of the *Engineering News*, of New York. Mr. Wellington is an engineer of experience, having served as Assistant Engineer on the New York, Pennsylvania & Ohio, Locating Engineer of the Mexican National; Assistant General Manager of the Mexican Central, in which capacity he located the Guadalajara Branch of that road, and in other important positions. For several years past he has been Associate Editor of the *Railroad Gazette*. Mr. Wellington is author of the "Economic Theory of the Location of Railroads," and of many contributions to engineering papers. He has been an active member of the American Society of Civil Engineers, and has contributed a number of papers to its proceedings.

Mr. John E. Wootten, for a number of years General Manager of the Philadelphia & Reading Railroad, has finally resigned that position, his health not having sufficiently improved to enable him to resume the duties of the position on Jan. 1, as he had expected to do. Mr. Wootten has been connected with the Reading road continuously for more than 41 years, having begun work in 1845 as foreman of the roadway shops at Pottstown. Two years later he was made foreman of the Palo Alto repair shops, and in 1854 he was transferred to the more important shops at Port Richmond. He remained in charge of these shops for ten years, and was then made Superintendent of the Mine Hill & Schuylkill Haven Branch. In 1866 he returned to the machinery department as its head, having been appointed Engineer of Machinery, and in 1871 the duties of Assistant Superintendent of the road were added to those of his former position. In 1873 he became General Superintendent of the road, and four years later was promoted to the position of General Manager. A few months ago he received leave of absence on account of impaired health.

Mr. Wootten is thoroughly familiar with the Reading road, having been connected with it for a longer period than any other person now prominent in the management. He is also well known to mechanical engineers as the inventor of the Wootten fire-box, the use of which has been increasing for several years past. He early recognized the necessity of increasing the grate area to meet the constant demands for increased power from the locomotive boiler, and his fire-box is the best known and most practical of the attempts so far made to put this principle into practice. Mr. Wootten's many friends will hear with regret of his present retirement from active work.

Notes and News.

Poughkeepsie Bridge.—The large caisson for Pier No. 5, has been launched and is now receiving the upper courses of timber.

German Enterprise in Mexico.—German manufacturers of agricultural machinery are said to be arranging for a united effort to introduce their machines into Mexico.

The Bridge Pier in the Mississippi, at St. Paul, erected by the Minnesota & Northwestern Railroad, the Secretary of War says, is an obstruction to navigation, and asks Congress to take action.

Ries Electric Railroad Manufacturing Company.—This company has been organized at Portland, Me., with $1,000,000 capital stock to build railroads and electric motors on the Ries system.

The Lehigh Valley Company is about to build a coal storage trestle in Chicago, which will be 100 × 886 feet. It will have a storage capacity of 25,000 tons, and arrangements for loading 30 cars at once.

The Dam across the Potomac at the Great Falls is nearly completed. The tunnel intended to carry the water supply of Washington from the dam is excavated for 18,538 feet, leaving 2,150 feet to be completed.

The Reese Safety Brake.—The automatic freight-brake invented by Alvan Reese, of Pittsburgh, is to be put on a number of cars on the Baltimore & Ohio road. The brake is made by the Reese Safety Brake Company, of Pittsburgh.

Compound Locomotives in England.—The London & Northwestern Company's experience with compound locomotives on the Webb system has been so favorable that it is now building 30 locomotives of that type, at its Crewe Works.

A "Hydro-Pneumatic Brake."—A brake thus described is to be manufactured by the Hydro-Pneumatic Car Brake Company, which has just been organized by William Susby, Jr., and others, at Newport, Ky., with $1,000,000 capital stock.

Cable Railroad in China.—A cable railroad has been built at Hong Kong, running from the city to the top of the Peak, a steep hill on which are situated a number of dwellings occupied by the European residents. The road is 4,800 feet long and rises 1,300 feet.

Ship-building in England.—Ship-building on the Tyne, in England, in 1886, shows a considerable reduction from 1885. Last year 67 vessels were launched, having a total tonnage of 82,800, against 106,000 in 1885. The average tonnage of the vessels launched last year was 1,236.

South Pass Jetties.—The report of the Secretary of War notes that, at the South Pass jetties of the Mississippi River, the channel has been maintained as required by law, and Capt. Eads has received the required payments of $150,000. The total cost of this improvement to date has been $5,300,000.

Trial of English Permanent Way.—A contemporary reports that the Pennsylvania Railroad Company will try a few miles of track laid in the English fashion, with rails of bull-head pattern, heavy cast-iron chains, and about 2,000 ties to the mile, or one-fourth less than are usually used in this country.

Washington Railroad Stations.—The Engineer Commissioners of the District of Columbia, in their annual report refer at some length to the railroad question, and urge the concentration of the railroad tracks entering the city of Washington. They also recommend the removal of the railroad tracks from existing streets.

Burlington Brake Test.—The Wells & French Co. is building at its shops in Chicago a train of 50 box cars for the Eames Vacuum Brake Company, to be used at the Burlington tests in April next. These cars are, of course, equipped with the Eames automatic freight brake; they are fitted with the Boston automatic coupler.

Cairo Bridge.—The engineers of the Illinois Central Railroad are now making the final location for the bridge over the Ohio River at Cairo, and work has been begun on the approach on the south side, which will include a trestle 3,000 ft. long. The bridge itself will be about a mile long and 52 feet above high water; the approaches will be about 1½ miles long.

Refrigerator Cars.—The New York, Lake Erie & Western Company has built 10 refrigerator cars, at its Susquehanna shops, which are to be run as express cars on passenger trains. These cars are 50 feet long, and are divided into three 16-feet compartments. They have passenger-car running gear, Miller platforms and couplers, and are fitted with the automatic brake.

Niagara Suspension Bridge.—Important improvements have been made this season in the Suspension Bridge over the Niagara River. These include the strengthening of the old anchors for the cables and the addition of new anchors. New steel towers have been erected in place of the old stone towers. The operation of transferring the cables to the new towers was successfully performed.

Union Switch and Signal Company.—This company has bought from the Pennsylvania Steel Compay the interlocking switch and signal department of its works, including the Cummings and other patents covering the system adopted by the Pennsylvania Steel Company. The business will be transferred to the new works of the Union Switch and Signal Company at Swissvale, near Pittsburgh.

A Russian Oil Pipe Line.—The United States Consul at Odessa, Russia, has notified the State Department that arrangements are to be made to build a pipe line to transport petroleum from Baku to Batoum. The line will be about 550 miles long, and its greatest elevation about 3,000 feet. It is proposed to use 7-inch pipe. The Consul thinks that American pipe and pump manufacturers will have an opportunity to secure contracts.

Liquid Fuel in Russia.—Some of the large factories in Odessa are now using as fuel in their boilers petroleum refuse, which is brought to Odessa by sailing vessels and is sold at a very low price. It is claimed that with the furnaces in use, a ton of this petroleum refuse will make as much steam as two tons of English coal. Arrangements are being made to carry the oil refuse in bulk from Novorossisk, the port of the Black Sea petroleum fields.

English Iron Production.—*The Engineer* estimates the pig-iron production of the United Kingdom for 1886 at 6,800,000 tons, against 7,250,657 tons in 1885; a reduction of 450,657 tons, or 6¼ per cent. The decrease in production has been continuous since 1882, when the total reached 8,498,000 tons. The reduction was not by any means uniform, the furnaces in Scotland and in the Cleveland district showing a small increase last year over 1885.

Railroads in Persia.—It is given out from St. Petersburg that Russian influence, which is very strong at Teheran, will be brought to bear to prevent the building of any railroads in Persia by English or American contractors. The Russian Government, it is said, is decided in its opinion that any important line to be built in Persia must connect with the Central Asian road which Russia is now building, and the Persian railroad administration must be controlled by Russian influences.

German Rails for English Colonies.—The Government of Victoria (Australia) has placed a contract for 50,000 tons of steel rails with the Krupp Works, at Essen. The deliveries are to extend over two years, and the price is said to be about $20 per ton, delivered on board ship. The bid of the Krupp Works was from $2.50 to $3 below the prices offered by English firms. Naturally, the English makers are much exercised in mind at so large an order from an English colony going to a German mill.

American System of Irrigration in Australia.—The Government of the Australian colony of Victoria has granted 50,000 acres of land to Chaffee Brothers, American capitalists, who are to colonize the land and improve it by irrigation. The land is near Mildura, on the Murray River, 11 miles above the mouth of the Darling. The conditions of the grant are that Chaffee Brothers are to spend $1,500,000 on irrigation works, and are to improve at least 47,000 acres of the tract within 20 years.

The Heating of Cars by Steam is tried on several railroads this winter. The Connecticut River Railroad has in use the Emerson system; the Boston & Albany has the Martin system as prepared by the Martin Anti-fire Car Heater Company, of Dunkirk, N. Y.; the Long Island Road is trying the Martin system on one train, and the Gold system on another. The Gold system has also been put in use recently on the Providence, Warren & Bristol Road, and on the cable road at Hoboken, N. J.

Blast Furnaces of the United States.—Statistics collected by the *American Manufacturer*, show that on January 1, 1887, there were 333 furnaces in blast, having a weekly capacity of 127,660 tons of pig-iron; against 273 in blast, with a capacity of 97,050 tons on January 1, 1886. Of the furnaces in blast this year, 66 use charcoal as fuel; 126, anthracite coal, and 140, bituminous coal or coke. The weekly capacity of the charcoal furnaces in blast is 11,895; of the anthracite, 53,633, and of the bituminous furnaces, 90,032 tons.

The Hoosac Tunnel.—The Troy & Greenfield Railroad, including the Hoosac Tunnel, has been sold by the State of Massachusetts to the Fitchburg Railroad Company. The State receives for the raad and tunnel $5,000,000 in bonds bearing 3 per cent. interest for five years, 3½ for five more and then 4 per cent., and will also receive $5,000,000 in stock of the company. The railroad and tunnel have cost the State (including interest paid) about $24,200,000. The price secured is probably the best that could be now obtained.

New Blast-Furnaces.—On Jan. 1, there were 22 new blast furnaces under construction. Of these, there were in the South 12, to have a productive capacity of 7,450 tons weekly; and the North 10, with a capacity of 7,800 tons weekly. Of the northern furnaces, three are at Troy, N.Y., the rest in Pennsylvania. Of the southern furnaces, one is in Kentucky, one in Tennessee and 10 in Alabama. The northern furnaces are generally larger, having an average capacity of 780 tons weekly, against 621 tons for the southern furnaces.

English Steamer for the Central American–New York Trade.—Robert Duncan & Co., Port Glasgow, Scotland, recently launched a steel screw steamer of 1,615 tons, intended for the fruit trade between Central American ports and New York. She is 236 ft. long, 35 ft. beam and 19 ft. depth of hold. The engines will be of the triple-expansion pattern, with cylinders 23 in., 35½ in. and 57 in. diameter, and 39 in. stroke. Steam will be supplied from two boilers, each 13 ft. 6 in. by 10 ft. 6 in., intended to carry a working pressure of 160 lbs.

Bridges at Minneapolis.—Plans have been prepared for three bridges over the Mississippi, at Minneapolis, Minn. One at Twentieth avenue will have four spans of 200 feet each, one at Franklin avenue, five spans of 200 feet each, and one at Lake street, six spans of 200 feet each. Work is in progress on a steel arch bridge at Hennepin avenue, which is to have two spans of 260 feet each. City Engineer Andrew Rinker is preparing plans for another bridge to cross the river at the falls; this will have one span of 540 feet, one of 200 feet and and three of 160 ft. each.

Lake Superior Iron Ore.—A good indication of the increase in the iron trade is found in the shipments of iron ore from the Lake Superior region. According to the Marquette *Mining Journal* these amounted last year to 3,541,996 tons, against 2,456,548 in 1885; an increase of 1,085,448 tons, or 44 per cent. Last year's shipments were the heaviest ever made, partly on account of increased demand, and partly because of the opening of mines on the new Gogebic Range. The total shipments of ore from the Lake Superior region up to the close of 1886 have been 29,774,099 tons.

The Union Bridge Company has its shops, both in Buffalo and Athens, Pa., fully employed. The work in progress includes the material for two notable structures, the bridge over the Hudson River, at Poughkeepsie, and the Hawkesbury River for New South Wales. A number of bridges for western and southwestern roads are also in progress, including one of 400 feet span over John Day's River, in Oregon, for the Oregon Railway & Navigation Company. This company is negotiating for the purchase of the rolling-mill property at Elmira, N. Y., and will, it is said, move its Athens shop to that place.

Ship Railroad at the Dalles of the Columbia River.—The project for a canal around the Dalles of the Columbia River, in Oregon, has been abandoned for the present, on account of the great expense involved. It is now proposed to build at the Dalles a ship railroad on the plan of Capt. Eads, by which steamboats can be taken from the water and transferred around the obstructions. It is thought that such a railroad can be built for $1,500,000, and an effort will be made to get an appropriation from Congress. At present the commerce of the river is impeded by the necessity of transferring all freight at the Dalles.

Russian Railroads.—The Russian Government has decided to begin no new railroad work in 1887, chiefly for financial reasons. Work will, however, be continued on the lines already sanctioned, of which some 750 miles remain to be completed. The most important lines now under construction are the Siberian Railroad, from Samara to Ufer, 440 miles; the Pskoff–Rjeff line, 255 miles; the Gomel-Briansk line, about 175 miles, and the Novorossisk-Tikhorelsk line, 170 miles. Several other lines have been urged to serve wheat-growing districts, but all are postponed for the present, the military lines receiving the preference.

Ohio Engines for Massachusetts.—The Prospect Engine and Machine Company in Cleveland, O., recently completed a pair of automatic engines, for the Lowell Carpet Company, in Lowell, Mass. These engines have cylinders 39 inches diameter and 40 inches stroke. The cranks are disks 72 inches diameter; the crank shaft is 20 inches diameter and 22 feet 10 inches long. The crank pins are 10⅜ inches diameter. The connecting rods are of the solid end type. The fly-wheel is 20 feet diameter and its face is 6 feet; it will carry three belts, two of 40 inches wide and one 36 inch. The engines will make 80 revolutions a minute.

Elevators for the New York Elevated Roads.—An association of property owners, known as the North Central Park Improvement Company, is making arrangements to put up a substantial building containing four passenger elevators in connection with the 116th street station of the Sixth avenue elevated road in New York. This building, when completed, will be leased to the Manhattan Railway Company at a nominal rental, that company to maintain and operate the elevators. The 116th street station is at the highest point on the road, and the great height of the stairways has been a serious drawback to property in the neighborhood.

East River Bridge.—The proposed bridge over the East River, at 60th street, New York, is to be pushed, and a bill, which has been prepared to authorize its construction, will soon be introduced in Congress. It is now proposed to start the eastern approach near Calvary Cemetery, west of Long Island City. The western approach is to form a Y, one arm extending to Fourth avenue and 42d street, the other to the Harlem Railroad track at 80th street. The bridge proper will be 155 feet above mean high tide, and is to have double railroad tracks, a carriage-way and foot-way. The total length of the proposed bridge and the approaches will be nearly 3½ miles. The design is for a cantilever bridge, the plans having been prepared by Mr. C. C. Schneider.

A Three-cylinder Locomotive.—The Dunmore Iron & Steel Company, at Dunmore, Pa., has a small locomotive in use switching in its yards which is of a novel pattern. It is thus described by the Superintendent of the works: "This little engine has three 8 × 12 in. steam cylinders, four 33-in. driving-wheels, two outside connecting and parallel rods, and one inside connecting rod. No balancing is needed in driving-wheels. The engine has six exhausts to a revolution, and the effect on the fire is good. It is claimed that by setting the cranks at an angle of 120 degrees the slip is reduced to a minimum. This engine makes 30 miles an hour on a 40 ft. grade easily, with a light load, and is considered a good machine by those who have run her. Its weight is about 12 tons."

Broken Axles and Rails in England.—*The Engineer* says: "Of the 238 axles which failed during the first nine months of 1886, on our lines, 147 were engine axles, viz.: 130 crank or driving, and 17 leading or trailing; 20 were tender axles, 2 were carriage axles, 63 were wagon axles, and 6 were salt-van axles; 29 wagons, including the salt-vans, belonged to owners other than the railway companies. Of the 130 crank or driving axles, 91 were made of iron and 39 of steel. The average mileage of 85 crank or driving axles made of iron was 233,057 miles, and of 39 crank or driving axles made of steel 223,933 miles. Of the 164 rails which broke, 79 were double-headed, 83 were single-headed, 1 was of the bridge pattern, and in one case the pattern was not stated; of the double-headed rails, 49 had been turned; 31 rails were made of iron and 133 of steel."

"Strong" Locomotive.—A second locomotive of the "Strong" pattern has been turned out of the Lehigh Valley shops at Wilkes-Barre, Pa. This locomotive has two fire-chambers, each consisting of a corrugated steel flue, both being joined at the forward end to single combustion chamber. From this chamber 309 flues, 1¾ inches diameter and 11 feet 5 inches long, extend to the smoke-box. The fire-chambers are each 42 inches diameter and 9 feet long. The total grate area is 62 square feet, and the heating surface is 1,848 square feet in all. The fuel is anthracite coal. The engine is intended for passenger service; has 20×24 inch cylinders, and six 62-inch driving-wheels coupled, 5 feet 7 inches from center to center, making the rigid wheel-base 11 feet 2 inches. There is a four-wheel truck under the cylinders, and a two-wheel truck back of the drivers and under the fire-chambers. This trailing truck is equalized with the drivers. The valve-gear is of the "Strong" pattern.

Car Coupling in England.—In England, as well as here, railroad men are struggling with the car-coupling problem. There, as in this country, attention was called to the subject by the many accidents to employés in coupling cars, but the railroad companies do not seem to have taken it up with as much earnestness as they have on this side of the water. Very little has been done by the roads or their officers, and the most important work so far has been done by the employés themselves. The Amalgamated Society of Railway Servants, an organization to which we have nothing to correspond in

this country, some time ago made from its funds an appropriation of £500 to be distributed as prizes for the best automatic couplers, and to cover the expenses of trials. These trials were made at Nine Elms, on the London & Southwestern road, last March, when a number of couplers were tried and prizes awarded. No practical results, however, have yet followed the trial, the average English mechanical superintendent being, apparently, much more reluctant to act on this question than his American brother.

Hennepin Canal.—The Secretary of War has transmitted to Congress a report of the Board of Engineers appointed to examine the line of the proposed Illinois & Michigan Canal, better known as the Hennepin Canal. The report is generally favorable, and the Secretary says that the construction of the canal will be a commercial benefit to the country; whether that benefit will be so great as to justify its construction, is left for Congress to decide.

The report says that the construction of the canal is feasible and discusses the routes proposed, which are three in number, the line to Rock Island, the Watertown line and the route by the Marais d'Osier, reaching the Mississippi at Albany, Ill. The board believes that while the Marais d'Osier route is preferable from an engineering point of view, as the shortest and cheapest and involving the least lockage, yet, in view of the relations of the Canal to existing transportation lines, it is inclined to recommend the southern, or Rock Island route.

These conclusions of the board are approved by Gen. Duane, Chief of Engineers.

New Bridge at St. Louis.—A bill has passed both Houses of Congress, providing that the St. Louis Merchants' Bridge Company, of St. Louis, may build a bridge across the Mississippi at some suitable point between the present bridge and the mouth of the Missouri. It is also provided that no bridge shall be constructed across the Mississippi River within two miles above or two miles below the bridge heretofore constructed, known as Ead's bridge. Said bridge shall be constructed to provide for the passage of railroadtrains, and, at the option of the persons by whom it may be built, may be used for the passage of wagons and vehicles, for the transit of animals and for foot passengers; the bridge shall be made with unbroken and continuous spans, and it shall have at least two channel spans of not less than 500 feet clear width each, and one span of 300 feet clear width of channel way; provided, said bridge may have not less than two spans of not less than 750 feet each, clear width of channel way, if thought best, instead of three spans as aforesaid. The channel ways are to be measured at right angles to the current at any and all stages of water; and said span or spans shall not be of less elevation in any case than 50 feet above high-water mark, as understood at the point of location, to the bottom chords of the bridge, and the piers of the said bridge shall be parallel with the current of the river.

The projectors intend to build the bridge north of the present bridge, and to establish, in connection with it, a new union station for such railroads as may use the bridge.

New Jersey Junction Railroad.—This new road, which is now nearly completed, is a work of some importance, forming a sort of belt line around Jersey City and Hoboken, and connecting the lines running to the Hudson River. It begins at Weehawken Ferry at the east end of the West Shore tunnel, passes straight along the shore, around King's Bluff, and through the stock-yard, coal and oil docks of the Erie road. Thence it runs at the foot of the hill on the western edge of Hoboken, and passes under the Delaware, Lackawanna & Western, a little east of the east end of the tunnel under Bergen Hill. It then rises along the bluff, crosses the Erie road on an iron viaduct 300 feet in length. This is about 200 ft. east of the east end of the Erie Co. tunnel under Bergen Hill. The road then descends, and passes under the Harsimus freight line of the Pennsylvania road to a connection with the new main passenger line of the Pennsylvania road, now in course of construction. A branch road connects with the freight line near Sixth and Division streets, Jersey City. To the connection with the Pennsylvania Passenger line the road is 4½ miles long. The Harsimus branch connection is ½ mile long. From Weehawken to connection with the Erie it is constructed with three tracks, two of which are used as the main track, and the third one for the Erie road's connection with its oil, stock and coal business of their Weehawken terminal. The road is now completed to the viaduct over the Erie. The work of construction is being done by the New York Central & Hudson River Company. From the Pennsylvania tracks to Communipaw it is continued by the National Docks branch of the Pennsylvania Railroad.

Meigs Elevated Railroad.—Mr. George Stark, Civil Engineer, has made a report to the Massachusetts Railroad Commissioners, on the experimental section of elevated railroad, on the Meigs pattern, which has been built in East Cambridge., This section has a grade of 120 feet and one curve of 50 feet radius. It is equipped with an engine weighing 30 tons and a passenger-car weighing 17 tons. Mr. Stark's report gives the following conclusions:

"The experimental section of the Meigs elevated railway now in use at East Cambridge is, in my opinion, abundantly strong for its intended use as an elevated railway track, and is safe for the passage of its equipment.

"The rolling stock and motive power used thereon is also strong and safe for its intended use, no breakage having occurred, or being likely to occur, that could imperil personal safety, either in or out of the cars.

"A line of railway, properly constructed on this principle, for passenger or freight traffic, and equipped with such rolling stock and motive power, on this principle, as the Meigs company is now prepared to perfect and build, would, in my opinion be, at least, as strong and safe for any kind of traffic as the ordinary surface or elevated steam railways now in common use.

"In view, however, of the imperative necessity for the best class of design and construction in everything appertaining to an elevated railway, I think it would be wise for the State of Massachusetts, through its Board of Railroad Commissioners, or otherwise, to regulate the strength and design of all materials used in construction, and the weight and design of equipment to be run, etc."

Logging Railroads in the United States.—The *Northwestern Lumberman* has been collecting statistics as to railroads used exclusively for logging or lumbering purposes, and gives the following statements:

Number of Railroads	383
Total length, miles	2,288
Number of locomotives in use	428
Number of cars in use	5,182

The total mileage includes 1,011 miles of standard gauge and 1,001 miles of narrow gauge. Of these roads 291, with 1,851 miles of track, are laid with iron or steel rails and use locomotives; 92 roads, with 399 miles of wooden and 38 miles of iron track, use animals as motive power. Most of the wooden roads are temporary affairs only. The more permanent lines with iron rails represent a considerable investment for construction and equipment.

The average length of these logging roads is about 6 miles only, but there are some of considerable length, one in Arkansas claiming 45 miles; one in Virginia 45; one in North Carolina 30, and one in Michigan 36 miles.

The variety of gauges is great, the narrow-gauge lines including roads of 24, 30, 36, 39, 42 and 45 in. The *Lumberman* counts up 37 different gauges in all. Not all are narrower than standard gauge, however. Washington Territory reporting roads of 7 ft. 6 in., 8 ft., 8 ft. 4 in. and 9 ft. gauge. These very wide gauge lines are all short, and all, except one, have wooden rails, and are operated by ox or mule power.

Michigan, as might be expected, leads the list, having 54 roads, with 283 miles of track, 60 locomotives, and 1,370 cars. Georgia is second, having 32 roads with 225 miles of track, 61 locomotives, and 244 cars. Other States having a considerable mileage, are: Florida, 176; South Carolina, 170; Pennsylvania, 168; Texas, 153; Alabama, 146; Virginia, 126, and California, 114 miles.

It must be remembered that many of these logging roads are not permanent in their nature. They are used until the adjoining section is stripped of its lumber, then taken up and laid elsewhere. Some, however, gradually develop into permanent lines, and are used for general business after their original purpose has been served. This has been the case with several lines in North Carolina and Georgia, where local railroads have grown out of logging tramways.

Ordnance for the Navy.—Commodore Montgomery Sicard, Chief of the Bureau of Ordnance, in his annual report to the Secretary of the Navy, says that during the year a number of the 6 in. high-power steel guns have been finished and fired at the naval ordnance proving ground. They have all endured proof in a very satisfactory manner, and over 2,000 ft. muzzle velocity was readily obtained with standard powder and projectiles and moderate chamber pressures. The two 5-in. guns for the *Chicago* have been finished since the last report. One has been fired with very satisfactory results. The first 8-in. gun finished, has also been proved with the same results. Chase and muzzle hoops for heavy guns have been made in the United States, and, as far as fitted, are satisfactory in quality. The 2-in. guns are well advanced. Under the head of projectiles Commodore Sicard comments upon the unsuitable character

of cast-iron as a material for projectiles intended to be used in high-power guns, and the failure of steel-makers to supply unhammered cast-steel shells of good quality. The report also states that unsatisfactory results have attended the efforts of the Bureau to use unhammered cast-steel for gun-carriages, but samples have recently been submitted and severely tested with results that encourage persistence in the effort. Under the head of machine guns and cannon the report notes the tendency abroad to increase the caliber of such cannon, and the opinion is expressed that pieces throwing projectiles of 20 and 30 pounds will soon be perfected. Cartridges for Hotchkiss guns have been produced in this country which perform better than those made abroad.

Touching the armament of the new vessels, Commodore Sicard says: "For the new ships approaching completion we have eighteen 6-in. and two 5-in. guns finished, and three 6-in. and five 8-in. well advanced, together with all the carriages for the *Atlanta* and *Boston* and all for the *Chicago* except the 8-in. All the guns of the secondary batteries and nearly all the small arms have been provided, and all the electric search lights and appendages. The mounts for the secondary batteries are being pressed; most of the powder of the *Atlanta* and *Boston* is delivered, and that for the *Chicago* will be ordered speedily. The equipments of the unfinished ships are now in a forward state. The South Boston Iron Works have virtually completed the 6-in. guns, which are to be assembled and finished there, and the two 8-in. guns are being pushed. The West Point Foundry has made good progress on the guns that are to be finished there. The contract of the Midvale Steel Works for 6-in. forgings is nearly filled, only a few remaining to be furnished."

As the third-rate wooden ships last built are good examples of the best class of wooden vessels, and must be depended upon to do most of the work of the navy until replaced by new ships, the report says it is desirable that they should receive a modern armament, as the impression they produce without it is but slight. When they are replaced, the armament will answer for the newer vessels. A new site for the naval ordnance proving ground is recommended in view of the unsuitable character of the ground now in use. A class of 21 commissioned officers and four gunners received instruction during the summer months on torpedo warfare. The estimates submitted for the next year aggregated $8,741,494, including $1,500,000 toward the armament of vessels authorized, and $1,086,750 for fuel, labor, general armament, and a new proving ground.

Arthur Kill Bridge.—The report of the Board of Engineers to the Secretary of War on the proposed bridge over the Arthur Kill on the Baltimore & Ohio line to Staten Island, is accompanied by documents, giving in detail the data on which the report is based. It says that the amount of freight which annually passes the site of the proposed bridge across the Arthur Kill will approach 5,750,000 or 6,000,000 tons of actual freight, an amount in excess of the tonnage of foreign commerce cleared from New York for 1885. It is thus seen, says the report, that so far as tonnage is concerned, this is one of the great waterways of this country, and indeed of the world. Of this vast amount of freight probably nine-tenths is in tows, sometimes reaching 70 vessels to one tow. The tows are usually made up of five vessels abreast and are eight vessels long, and their dimensions are 100 to 125 ft. in width by about 800 ft. long. Under the plan submitted by the Staten Island Rapid Transit Company such masses of vessels are to pass through a clear opening between piers of about 200 ft. The report says that the experience at the draw at the mouth of the Raritan River, through which only about one-third as much freight passes as through the Arthur Kill, and which has 207 ft. draw openings, shows that the draw at that place is a serious obstruction to navigation and has caused considerable losses from delays and collisions. The tows to go north through the Arthur Kill pass the proposed site of the bridge while the tide is running flood, and when any collision would produce great damage. They are much larger than those passing through the Raritan draw, and it is impracticable for these large tows to anchor as the smaller ones do at the Raritan draw. The board is therefore of opinion that if a bridge were constructed as proposed, with a pier in the middle of the Kill, it would make necessary a large reduction in the size of the tows and the consequent increase in the cost of transportation, and it is of opinion that if there were a natural obstruction so serious as a pier in the middle of the stream its removal would be urgently and rightfully demanded, even at great cost. The obstruction is not there now, and should not be placed there to the injury of navigation in order to save a few hundred thousand dollars to the railroad company.

The proposed bridge, the report says, is also of insufficient height, the lowest part of the superstructure being only 34 ft. 8 in. above mean low water. For these reasons the board recommends to the Secretary of War a bridge at the site proposed, the channel face of whose east pier shall be on the Staten Island bulkhead or shore line, and whose channel span shall give a clear opening of 450 ft.; whose span next west shall be a draw span, giving 125 ft. clear opening, the lowest parts of these spans being 50 ft. above mean high water. The foundations of the pier should be so arranged as to admit future deepening of the Kill to 20 ft. "Such a bridge will be an obstruction and an inconvenience," the report says, "but will not in any serious degree increase the cost of transportation. It involves some increase of cost to the railroad company, but no more than it should bear rather than infringe on the pre-existing rights of navigation."

A draw on the proposed Buckwheat Island site, the report says, would be impracticable for the reason that the channel has only 6 ft. of water on one side and on the other side the channel is narrower than at the site recommended.

No action has yet been taken on this report by the Secretary. A bill has been introduced in Congress to amend the act passed last year in accordance with the engineers' suggestions.

Park Electric Brake.—This brake, which is to take part in the Burlington trials next April, was recently tried on the Chicago, Burlington & Quincy road. It is thus described:

"A dynamo is placed on the locomotive, and is driven by a small independent engine. The whole affair is easily detached from the locomotive and weighs about 400 lbs. Three wires run the length of the train, and at each end of each car are coupled together by a very simple device, one coupling serving for the three wires. The brake is non-automatic, or in other words, does not apply in case of a break-away, but it is proposed to add a storage reservoir at the rear end of the train, whereby the conductor could apply the brake in case of the train parting. As, however, applied to the trial train, the brake is non-automatic, and the current only runs through the wires when the brakes are being applied or released from the engine. Normally, when the train is running, or standing with the brakes off, there is no current in the wires.

"The engineer applies and releases the brakes by moving a lever on an electric switch-board on the engine. The current applying the brakes runs to the end of the train through one wire and returns through the center wire of the three used. When the lever on the switch-board is moved to the release position the current runs through the third wire, releasing the brakes, and returns through the center wire as before. Whenever the coupling at the end of the train is pulled apart, the wires automatically make the proper connection in the coupling, so that the current when applied will make a circuit the length of the train and through the center wire. It will thus be seen that the couplings require little attention. They are very easily coupled by a single operation, and the coupling at the end of the train is simply allowed to hang loose, and does not require to be placed in a rest or closed with a plug or a stop-cock or any similar contrivance.

"To apply the brake shoes, an eccentric is mounted on one axle of each car. The end of the eccentric rod can, by means of pawls, be made to engage in ratchet teeth on the periphery of a cast-iron drum, carried on the under-side of the middle sills of the car. This drum also carries a chain which is attached to the brake and levers in the usual manner. The passage of an electric current along the train causes the pawls worked by the eccentric current rod to engage the drum, which consequently rotates and winds up the chain applying the brake shoes. A second pawl prevents the drum running back when the pawl driven by the eccentric rod is moving back to take a fresh stroke. When the current applying the brake is stopped (by the lever or the switch-board being thrown into the middle or neutral position), the applying pawl ceases to act, but the second pawl retains the brake on. When the releasing current is passed through the other wire, this second pawl is thrown out of gear, and the brakes come off. It is probable that these details will be somewhat modified.

"As the brake is applied by a few revolutions of the wheel, the shoes are full on in a very short space of time, and must be applied simultaneously throughout the length of a train, however long. The brake can be adjusted so as not to slide the wheels. When the brake is applied with what is deemed sufficient force, a small set-screw forms a contact, and shunts the current that holds the pawl applying the brakes. This pawl then drops, and the brake-chain drum is no longer revolved. The brake therefore continues to be applied with the proper maximum amount of force and is not released, the drum being prevented from running back by the second or retaining pawl already described. This pawl can only be lifted by the releasing current or by hand."

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 23 MURRAY STREET, NEW YORK.

M. N. FORNEY, ... **Editor and Proprietor.**
FREDERICK HOBART, ... **Associate Editor.**

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

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NEW YORK, MARCH, 1887.

THE bills before Congress appropriating money for new cruisers for the Navy, and those providing for new heavy guns for both the Navy and the Army and for additional defenses on the sea coast, have not passed nor even assumed final shape as the month closes. There is a considerable difference between the measures before the Senate and the House, and it is quite impossible to predict what shape these bills may receive at the hands of conference committees, or what action may be taken on them in the hurry of the last few days of the session.

That some action may be taken which will make it possible to begin work on the new guns which all parties seem to agree are needed by the country, is to be hoped for. If the guns must be had, the sooner work is begun the better.

THE discussions at the various railroad club meetings which are reported elsewhere, like those at the January meetings, failed to bring out much beyond expressions of individual opinion. Three or four roads were reported as additions to the list of those which are experimenting with systems of steam heating, but nothing new was given as to the results on those roads which have already tried such systems. Large attendances showed the general interest felt in the subject.

THE terrible accident at West Hartford, on the Central Vermont Railroad, in which over 40 people were killed, most of them being burned to death, has increased the public interest in methods of car heating which was aroused by the accidents at Republic and West Springfield early in January. There is a general demand for legislative action on this question, and in several States such action seems to be imminent. In New York, resolutions have been passed requiring the Railroad Commission to investigate the question and report to the Legislature.

IN the case of the Republic accident the Coroner's jury has brought a very severe verdict against the railroad company, charging it with using defective machinery, cars in poor condition and defective and dangerous heating apparatus. The West Hartford disaster, according to the Vermont Railroad Commissioners, who have investigated the accident, was primarily due to a broken rail; the loss of life, they find, was due chiefly, if not entirely, to the burning of the cars, which were set on fire from the heaters. The Commissioners recommend the disuse of the old stoves and heaters entirely, and the substitution of some of the steam heating or other safety systems.

IN nearly all the discussions in the daily newspapers and elsewhere, it seems to be assumed that the only possible method of heating cars safely is by steam taken from the locomotive, or at least from some source outside of the passenger cars. With this view, as has been heretofore noted, many railroad men of experience are not ready to concur, and it cannot be denied that their objections deserve careful consideration, even if they do show a somewhat too conservative disposition to condemn new methods and to keep to the old lines.

That some action must be taken on the safe-heating question is evident, and if the railroad companies do not take it voluntarily the chances are that they will be compelled to do it by law. The present danger is that, in one or several States, crude measures will be passed which will make endless trouble for the railroads and probably fail to accomplish their object. A general disposition on the part of managers to institute a reform without compulsion will be the best preventive of bad legislation.

THE usual line of promotion to the higher offices on railroads in this country has been either through the traffic department or the chief engineer's office; in the latter case an apprenticeship being generally served in the transportation department, either as division or general superintendent. There are very few cases in which the motive power department has been called upon, and the general managers or presidents who have been through that branch of the railroad service can be counted upon the fingers. The New York, Lake Erie & Western Company has just made a new precedent by promoting Mr. R. H. Soule, its Superintendent of Motive Power, directly to the office of General Manager. In this case, however, the promotion may be taken, not so much as a concession to the importance of the department, as to a recognition of work well done, and thorough equipment for future service in a high position.

THE Brake Committee of the Master Car-Builders' Association has decided to hold the second series of tests of freight-train brakes at Burlington, Ia., in May next, instead of April as originally intended. The rules for these tests (which will be found in another column) provide for twelve runs over the course with each train. There are ten brakes entered for the trials, and if all of these should appear, the tests will take between three and four weeks, judging from experience with last summer's trials. This will leave the Committee but scant time to prepare its report to be submitted to the Convention in June. May seemed to be the more acceptable time to all parties concerned, however, and so it was fixed.

More than half the work at the tests will be in the trial of the new brakes, which will then make their appearance as competitors for the first time.

The brakes now entered for the test are the Westinghouse, the American, the Eames, the Rote, the Widdifield & Button, the Ward, the Hanscom, the Carpenter Electric, the Waldumer Electric and the Park Electric brakes.

AN interesting feature in the brake trials, if all the competitors appear, will be the presence of several electric brakes, which will now, for the first time, make their appearance at a public competitive trial in this country. The Park brake has been tried, we believe, but has not been shown in competition with the older forms of brake, The use of electricity for this purpose has many promising features, but its practicability in daily service, under the hard conditions of ordinary freight traffic, has still to be demonstrated.

The Brake Committee deserves thanks for the time and work which its members have given and are still giving to these tests, the most thorough which have ever been made or even attempted in this country.

AN ENGINEERING LIBRARY.

EVERY American engineer who is interested in the literature of his profession, and especially those who, in making investigations, have had occasion to make use of such literature, must have felt the need of a good engineering library. At present, there is no collection of engineering books which approaches, even in a remote degree, to being as complete as it could be made by the expenditure of a comparatively small amount of money. Quite a number of libraries of engineering books have been started, but all of them are still very fragmentary and incomplete. The Astor Library has, perhaps, the largest assortment of such books in the country, but to supply the needs of any profession a library should be controlled by persons who know what those needs are ; or, in other words, by those who belong to the profession whose members are to use the books.

The American Society of Civil Engineers has a collection of books, received by donation and otherwise, which has now considerably outgrown the quarters provided for it. It is constantly increasing, whereas the building of the Society, like the raiment of a boy, does not grow. The consequence is that the library is in a state of more or less congestion, which promises to continue until money is forthcoming to extend the quarters now occupied by its owner.

The American Society of Mechanical Engineers has also the nucleus about which it is hoped there will ultimately be an accretion of books sufficient to form some kind of a library, and the Society has for some time past had under consideration measures looking to the foundation of a collection of books for the use of its members.

Some time ago, a move was made simultaneously in the two Societies in the American Institute of Mining Engineers and in the Society of Electrical Engineers to create a "joint library" for the use of those and other kindred organizations. Committees were appointed and several meetings were held, and the matter was discussed at considerable length. It was also proposed at these meetings that there should be a building provided in which some, if not all, the Societies interested in the library could each have rooms suitable for their uses. The members of the joint committee were unanimous that a library and a building for the accommodation of the Societies were very much needed, and the proceedings of the committee meetings consisted chiefly of remarks in which the desirability of the end proposed was emphasized. But, alas, saying and feeling how much a thing is needed does very little to create what is wanted. No definite plan of coöperation among the Societies was proposed. If a building is erected, the title and ownership must be vested in some person or persons authorized and qualified to act in that capacity. If four Societies combine to own property, how shall the title be held? If they undertake to establish a library, how shall it be managed? No very definite scheme was suggested to meet these difficulties, and it now seems very doubtful whether any other action will be taken by the joint committee to accomplish the ends for which it was created.

The need of a good engineering library is as great or greater than ever. All the impressive remarks which were made at the committee meetings on the importance and value of a good library are as true now as they were when they were made. The problem is to devise some practicable scheme of organization for the creation of such a collection of books as is wanted. A general, vague and indefinite scheme will not do—it must be a plan which will indicate the next step which should be taken, and that and successive steps must lead to the desired end. Now, who can devise such a scheme?

It does not seem probable that there would be difficulty in getting money or books for such a library. There are so many men in engineering occupations who are, and others who will be, rich that there will be no lack of means in the hands of those interested in a such a scheme. There can be very little doubt, too, that a considerable number of such persons would be inclined to contribute, either by bequest or otherwise, for the creation of an engineering library, if one was organized on a basis, and its management entrusted to hands which would ensure that money contributed would be wisely expended for the furtherance of the objects for which it was intended. One difficulty is, that a library must have a building to hold it. If this is ever provided, one-half the work is accomplished. It has not yet been announced what plans the trustees of the magnificent bequest of Mr. Tilden, for a public library, have made for carrying out the purpose for which the money was left. It would seem, though, as it would be a proper use of a part of it, if the trustees should, in erecting a building, arrange it so that a portion could be devoted to the reception and care of a technical library of books relating to the useful arts, which would, of course, include engineering. If this were done and the trustees would agree to assume the care of books contributed to this section, the engineering societies could then solicit contributions for the purchase of books relating to their own specialties, with an understanding that the money thus contributed should be expended under the direction of a permanent library committee consisting of members appointed from each Society.

The committee could be instrumental in soliciting contributions for engineering books, either by bequest or donation, and could indicate the deficiencies of the library and the needs of the profession. With such an arrangement more could be accomplished with the Tilden be-

quest and with the contributions for an engineering library, than either would alone. The Tilden trustees would, in effect, say to engineers and others, "we will furnish a suitable place and assume the care of books relating to your occupations, if you will supply the books;" and the joint-library committee would announce that contributions were needed for books in any given department or for special purposes which they might indicate, and that the committee would direct the expenditure either as its own members might think best or in accordance with the instructions of the donors. The committee could solicit and receive contributions, suggest bequests to the living, and take care of what might be bequeathed by the dead. It seems quite certain that a plan of this kind would insure a continuous and rapid growth to a technical library, without any expenditure on the part of the Tilden trustees, excepting that required for the housing and care of the books.

STEEL FOR HEAVY GUNS.

THE discussion on this subject, which was elicited by the paper of Mr. Dorsey, read at the meeting of the United States Naval Institution held in Annapolis in January, has attracted much attention, owing in part to the proposed large appropriations by Congress for the manufacture of ordnance. Mr. Dorsey is a civilian engineer and showed courage, perhaps temerity, in submitting his views for criticism by naval and military experts. His paper may be briefly summarized as follows: "The treacherous and capricious qualities of steel increase with its tensile strength and the size of the piece. Steel of a small size will have greater tensile strength than that of a large size if the work on each is the same. Hard steel is too unreliable to be used in its natural state, in large pieces, for any kind of structural work, and the great improvement reported in the working qualities of hard steel, caused by the oil bath on large pieces, have not been conclusively demonstrated, therefore, hard steel should not be used for the large guns. By the use of many and thin hoops or cylinders of mild steel, properly built up and proportioned, a gun can be made that will be at all times safe, reliable and unfailing. If hard steel, or steel of high tensile strength, in thick hoops, is used, the gun will be more costly and of greater theoretical strength, but practically much weaker, and will fail when least expected and without any apparent cause or reason."

Copies of the paper were sent to the friends and supporters of the author, as well as to other steel manufacturers and ordnance experts who were invited to be present or to communicate their views. The result is a discussion of much interest which has been published in the "Proceedings" of the Institute and occupies 125 pages of the volume.

A number of eminent civilians concur in the views of Mr. Dorsey, but evidences of dissent begin to manifest themselves as soon as we reach the discussion of the paper by expert manufacturers of steel and ordnance. Thus, Mr. Wellman of the Otis Iron & Steel Company says Mr. Dorsey's argument is "that because mild steel has been proved to be the best material for structural purposes and for steam boilers, therefore it is the best for heavy guns. The kind of strain put upon steel boiler-plates and structural material is of an entirely different kind from that to which gun steel is subjected, the former having to withstand nothing but steady loads, while the latter is continually subjected to shocks, and these of the most severe kind. * * * It has been repeatedly proved by many experiments with both kinds of steel that piston rods of steam hammers made of hard steel, and that above 0.50 per cent. in carbon, stand many times longer than soft steel, and that the softer the steel the shorter the life of the rod."

Lieut. Ingersoll, Head of Department of Ordnance and Gunnery, U. S. N. A., called attention to the fact that "in bridge and boiler construction the tensile strength, combined with an assumed factor of safety, limits the load the structure is calculated to stand, and this one quality is always kept in view. With gun-makers, however, the tensile strength is not considered at all in the design of a gun, but the elastic strength and the ductility—or elasticity if you please—of the metal within its elastic limit. Therefore, the *elastic strength* or the ability of a gun to resist permanent deformation, and *not* its *tensile strength* or its ability to resist fracture, is the quantity which limits the safe load with an assumed factor of safety. * * * Simply giving the *tensile strength* of a metal really tells very little about its fitness for gun construction. * * * We seek a metal which has a large percentage of *elastic elongation*, or elongation within the elastic limit, which characteristic aids the metal to resist the vibrating strain to which it is subjected."

Lieut. Ingersoll also called attention to experiments with oil tempering, showing that such experiments as have been made go to show that its effect is undoubtedly felt throughout the mass

Mr. Jas. Morgan, Jr., Chief Engineer of the Cambria Iron and Steel Works, said that the author's remarks as to oil tempering may be taken as an expression of opinion from one somewhat uninformed on the subject, and that the ordnance tests show the cooling effect will penetrate to the center of the largest gun hoops, with very trifling differences in hardness between the interior and outside corner. He also said the carbon or hardness of locomotive and car-tire steel, is not less than approved gun steel. Rails 0.30 to 0.40 carbon, axles 0.30 carbon, and many other things, are by no means mild steel.

Lieut. Austen M. Knight, U. S. N., in charge of the Naval Proving Grounds, Annapolis, said that the author of the paper believes that steel of this tensile strength cannot be made reliable and uniform; that it is and must be treacherous. In this, he differs from nearly every firm in the world which has had experience in the manufacture of steel in large masses.

Generally, it may be said that the experts in the construction of ordnance dissented from the views set forth in Mr. Dorsey's paper, while those who agreed with him had no special knowledge of the subject. The discussion is of very great interest at the present time, but it shows how dangerous it usually is for one who is not an expert on a subject of this kind to undertake to impart instruction to those who are.

A CORRECTION.

ONE of our cotemporaries has good-naturedly called attention to an error in our article on Heating Railroad Cars, in the February number of the JOURNAL. On the assumption that a Baker heater has 56 square feet of heat-

ing surface, it was calculated that twelve cars would have a total of 67.2 square feet, from which it was erroneously deduced that *probably* less than a half of one per cent. of the capacity of the locomotive boiler is required to heat a train of twelve cars. The error consisted in inadvertently taking the heating surface of the boiler at 12,000 instead of 1,200 square feet, and the percentage should have been "probably less than 5 per cent." instead of a half of 1 per cent. It is not asserted that these figures represent, even approximately, the actual proportion of the boiler capacity required to heat a train of cars. They indicate, though—and that is all that was intended—that only a small fraction of the boiler capacity is required to heat cars. Our cotemporary tries to prove, and it is not disputed, that "from 2½ to 3½ per cent of the total supply of steam is needed for heating." But what does it mean by the following sentence: "The same result, in substance, is reached by remembering that more square feet of grate surface an engine can comfortably burn 80 to 100 pounds of coal per hour, or 1,360 to 1,700 pounds, and computing the horse-power from that at 3 to 4 pounds per hour."

NEW PUBLICATIONS.

"TREATISE ON THE THEORY OF THE CONSTRUCTION OF HELICOIDAL OBLIQUE ARCHES."—*By John L. Culley, C. E.* Van Nostrand's Science Series, No. 87,

THE volume before us treats of a subject which is generally regarded as a kind of bugbear by the constructing engineer. Skew arches, which came into existence, or, at least, into frequent use, with the introduction of railroads, have been and still are avoided in every way possible; but cases occur when no contrivance nor ingenuity can excuse the necessity of an oblique crossing, and a skew bridge then becomes inevitable. The introduction of girders has overcome, in great measure, the difficulties of such cases, and it is safe to say that, in the future, very few oblique crossings will be made on masonry arches. But, here again, occasions will, from time to time, present themselves when, for one reason or another, it is considered preferable to use stone or brick rather than iron or steel, and the engineer or architect should certainly be prepared to meet such emergencies.

In Mr. Culley's little volume, one system—the helicoidal—of designing and constructing such arches is mainly dwelt upon, although some space is allotted to the consideration of the logarithmic method also. The latter we take to be the same as the orthogonal method of the French constructors. Which preceded the other in point of date of invention, we confess we do not know, but one would imagine that the helicoidal grew out of the effort to simplify the logarithmic by substituting straight lines for curves in the development of the soffit. Naturally, the latter is the more perfect and scientific method; there are limitations to the use of the former in the case of full-centered arches, which can, however, be overcome, Mr. Culley tells us, by means of special construction of the wing walls. It would have been useful to explain and illustrate such special construction. He enunciates a perfectly sound principle when he states that, for a considerable degree of obliquity, segmental arches are far preferable to full-centered ones. Indeed, the flatter the segment, the more nearly the helicoidal system approaches mathematical correctness, the limit being reached in the *plate bande*, where the soffit of the natural arch is the same as its development.

In his remarks upon centering for skew arches, Mr. Culley does not enforce the importance of its being particularly solid and well braced. This is absolutely necessary, in order that it may stand the various false strains to which it will be exposed. This adds considerably to the cost, and we may here observe that we cannot consider the comparison which Mr. Culley makes between the cost of skew and right arches as complete. The extra waste in getting out the voussoirs is a comparatively small item. We think a more serious source of increased expense will be found in the fact that the cutting and laying of stones with warped surfaces is a specialty, and not only requires the employment of men drawn from a relatively small class, but demands also more time and care than is called for in straight work.

Mr. Culley appears to us to be somewhat hasty in his sweeping condemnation of echeloned ribs as a means of effecting a skew crossing. Some admirable specimens of bridges constructed upon this principle exist in France, built by engineers of high standing. If securing great strength with the minimum of expenditure be a test of good engineering, then certainly the bridge carrying the Chemin de Fer de l'Ouest over the Chartres highway, built in this way, must be considered as reflecting great credit upon its designer, Monsieur Boucher. We believe this method owes its origin to the recognition of the comparative weakness of skew arches with high rise and great obliquity. In the bridge just mentioned, the span on the square is 9 meters, and the rise 5—a semi-ellipse, in fact, with the minor axis for span. The angle of skew is 36°. How should we design and build a helicoidal arch with these data?

So much for what may be termed "adverse criticism." It is pleasanter to be able to say that Mr. Culley's clever little volume is likely to prove very useful to those who have occasion to qualify themselves in the matter of skew arches. It would be too much to say of it that it clears away all the difficulties of the subject; the fact that the art of properly laying down the lines of such structures cannot be reduced to a general routine, but must vary with almost every particular case, precludes the possibility of doing this by book. But the present volume will be found of great help, and contains much which we do not think can be readily, if at all, found elsewhere. For the rest, we quite agree with Mr. Dobson ("Masonry," Weale's Series, No. 25) that the best way to get a full realization of the principles of the oblique arch is by constructing a model.

It is a pity that the otherwise neat pages of this book should be marred by a number of misprints.

"THE THEORY AND PRACTICE OF SURVEYING."—*Designed for the use of Surveyors and Engineers generally, and especially for the use of students in engineering. By J. B. Johnson, C. E., Professor of Civil Engineering in Washington University, St. Louis, Mo.* New York: John Wiley & Sons, 1886.

THIS octavo volume of 683 pages endeavors to cover the entire field of the science and art of surveying, first, by describing the construction, use and adjustment of all

kinds of instruments; and, secondly, by presenting the methods for the execution of land, topographical, railroad, hydrographical, mining, city and geodetic surveys. Each of these departments, indeed, is a science by itself, to the detailed development of which a volume might be devoted, and the author, in endeavoring to compass them all in a single book, has undertaken a heavy task. In general, however, it may be said that the task has been well performed, and that the book is likely to be a serviceable one to engineers, although much might have been gained by excluding a few of the special topics and devoting the space thus saved to the elaboration of others. This is particularly true in regard to railroad surveying, the chapter on which covers but twelve pages, and which gives but a very general and imperfect description of the methods of railroad location. The same may be said in regard to the subjects of the mean velocity of rivers and the gauging of streams by means of weirs, to which the author devotes part of a chapter. What is presented on these matters is, of course, valuable to those who have no other source of information, but it is possible that a dependence upon this alone might exemplify the maxim that a little knowledge is a dangerous thing.

The first part of the book, 171 pages, is devoted to surveying instruments. The methods for the adjustment of instruments are stated very clearly and satisfactorily, and the explanations given of the reasons for the operations will prove valuable to students, who are too often apt, as the author remarks, to memorize the methods without understanding the *rationale* of the process. We have not been able to find any definition of the term "line of collimation," which should, of course, be clearly understood by the student before attempting the adjustments which relate to it.

The chapters on land and topographical surveying are excellent and thorough. The remarks in regard to the precautions to be taken to ensure precision and in regard to allowable limits of error are suggestive and valuable, and form a distinctive feature of the book. Surveys are not merely to be made and plotted, but they are to be made so as to satisfy certain conditions of precision and economy. The old text-books gave us merely the mathematical methods, leaving the student to learn in the school of experience the degrees of accuracy which should be required in different classes of work, but the modern method, as exemplified by Professor Johnson, is in all respects more advantageous. The use of the steel tape, for instance, is scarcely alluded to by most text-books, although it has long been extensively employed in all classes of work; but the volume before us makes it the main instrument for the measurement of lines, and gives a thorough explanation of the manner in which it may be used to measure a base line with a high degree of precision.

One of the longest chapters in the book is that on geodetic surveying, which attempts to cover not merely the general theory and field work, but also the astronomical operations for the determination of time, azimuth, latitude and longitude. Probably the author has not given sufficient space to these topics to meet the demands of geodetic observers, as large volumes have been written entirely devoted to field astronomy. The adjustment of angles, quadrilaterals and triangulation systems can also be scarcely presented with satisfaction without previous explanation of the method of least squares. For the use of students in engineering schools, however, the chapter seems well adapted as an introduction to the subject. The author's suggestion that the helioscope may be improved by the omission of one of the disks, would probably not stand the test of actual trial unless the operator were an expert of high attainments.

In the computation of earthwork the prismoidal formula is closely followed as should be the case, and a table is given for the deduction of solidities directly from the field notes of cross-sections. The chapter on city surveys, by Mr. William Bounton, City Surveyor of St. Louis, emphasizes the fact that the common methods of land surveying are entirely inedequate in cities, and gives much valuable information in regard to monuments, standards of measure and discrepancies in records. The subject of mine surveying is well treated in the space of 23 pages. On the whole, this volume gives more of the practice of surveying than any other with which we are acquainted, while the theory is also well presented. The arrangement of the work seems better adapted for the use of engineers than for a students' text book, although it will doubtless prove more advantageous for the latter purpose than any other book which attempts to cover all departments of surveying.

"SAFE RAILWAY WORKING."—*A Treatise on Railway Accidents, their Causes and Preventions, with a Description of Modern Appliances and Systems.—By Clement E. Stretton, C. E.* London: Crosby, Lockwood & Co.

The author of this book is the Vice-President and Consulting Engineer of the Amalgamated Society of Railway Servants of England, an association corresponding somewhat with the Brotherhood of Locomotive Engineers in this country, although the two organizations differ a good deal in the classes of persons included in their membership and in the objects aimed at by them. The author also says that "it is his duty to examine, consider, and report upon the circumstances attending every accident, and the new or improved safety appliances necessary to prevent such occurrences in future." How many of the railroad managers and master mechanics would open their eyes if the Brotherhood of Locomotive Engineers should appoint some competent person to represent their organization in a similar way.

In the first chapter Mr. Stretton gives suggestions for safe railway working, some of which would be quite impracticable in this country, and the wisdom of some others would be disputed by managers here.

As an example, his second suggestion is that "all railways ought to be worked on the absolute block system *strictly carried out*, so that no two trains of any kind shall ever be in one section at one time." It will be a long time before this suggestion is adopted on all American roads.

The first chapter is succeeded by the inevitable historical one that most writers seem to think is essential in every technical book. In this case it is a history of permanent way. Its omission would improve the book.

The third chapter is on Railway Signaling and contains a description of the block and interlocking systems. It is very doubtful, though, whether any one unacquainted with these systems, would be able to understand either of them from the descriptions in Mr. Stretton's book. He

has, for years past, been an indefatigable writer for the newspapers, and it seems as though he had taken a collection of desultory articles relating to accidents, and made a book of them.

A chapter is devoted to Brakes, another to the Report and Awards of the Jurors of the Coupling Trials held at the Nine Elms Goods Yard of the London & Southwestern Railway last March.

The last chapter is devoted to Railway Servants and the Law. Mr. Stretton has done some good work in defense of the members of the Amalgamated Society against the improper or unjust administration of the law in cases of accident. He cites numerous cases in which injustice either had been done or was threatened to members of the Society, who were protected by its intervention in their behalf. That railroad employés sometimes need to be defended in this country in similar cases is probably true, although recent events have shown that corporations as often require to be defended from their employés.

Persons interested in railroad operation will find Mr. Stretton's book very interesting and, to some extent, instructive reading, but it belongs to a class of books which leads a reviewer to wonder why the author took so much trouble to make it as good as it is, and then did not make it much better.

BOOKS RECEIVED.

"INDIAN ENGINEERING;" Volume I, Nos. 1, 2 and 3 Published in Calcutta, India; Pat. Doyle, C. E., editor.

"Report of Proceedings of the Nineteenth Annual Convention of the American Railway Master Mechanics' Association."

"Report of the Proceedings of the Twentieth Annual Convention of the Master Car-Builders' Association."

OBITUARY.

WILLIAM WILLARD WILSON, Engineer and Superintendent of the Yonkers (N. Y.) Water Works and City Surveyor, died on February 7, in the 47th year of his age. He was born in New York City, but his parents moving to Havana he was there educated as a civil engineer. Mr. Wilson was appointed City Engineer of Yonkers in 1874, and prepared plans of the water works, on which, after some opposition, the works were finally built. Mr. Wilson was a member of the American Society of Civil Engineers, having joined the Society January 5, 1870.

M. BLAVIER, whose death in Paris recently is announced, was one of the most distinguished French electricians, Chief Inspector of the French telegraph lines, Director at the School of Telegraphy and Vice-President of the International Society of Electricians. M. Blavier was one of the promoters of the Paris Congress, in 1881, where the absolute system of measurement for electrical and magnetic magnitudes was adopted. His books on Telegraphy and on the Absolute System of Measurement are justly considered standard contributions to science. His experimental researches have also been fruitful of important results, and one of the last series of experiments undertaken was in connection with earth currents and was carried out with the assistance of Prof. Mascart.

JUDGE THOMAS RUSSELL, Chairman of the Massachusetts Railroad Commission, died at his residence in Boston, February 9. He was born in Plymouth, Mass., in 1825, graduated from Harvard College and studied law. He was successful at the bar, and when still a young man was appointed Judge of the Superior Court. After his retirement from the Court he entered actively into politics and held several offices, including those of Collector of the Port of Boston and United States Minister to Venezuela.

In June, 1879, Judge Russell was appointed Railroad Commissioner by Governor Talbot, to succeed Mr. Charles Francis Adams, Jr. He was the lawyer member of the Commission and as such did his full share of its work, although his previous training and experience did not enable him to fully replace his predecessor, under whose leadership the Massachusetts Commission attained so high a reputation. Judge Russell was, however, a faithful member of the Board and performed his duties carefully and intelligently. His death was caused by pneumonia.

Contributions.

The Faught Car Chill.

TO THE EDITOR OF THE RAILROAD & ENGINEERING JOURNAL: On page 89 of the February number of your journal the statement is made that, when many years ago I invented an improvement in car-wheel chills, I had mainly in view the prevention of the "disintegration of the inner surface of the chill by sawing its face into many sections." This statement is incorrect; the chill invented by me in 1876 was intended not so much to improve the chill, as to improve the chilling effect on the wheel itself. The chill was called by me at that time "a contracting chill" and acted substantially as such. The product from that chill, exhibited at the Centennial Exhibition was noted for its uniform and superior chill.

LUTHER R. FAUGHT.

PHILADELPHIA, February 16, 1887.

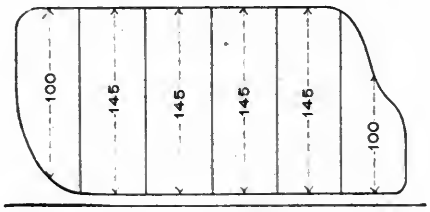
Tractive Power of Locomotives.

EDITOR OF THE RAILROAD AND ENGINEERING JOURNAL: There has been considerable interest taken in the fact that locomotives can pull more than the Pambour formula shows is possible. I believe the following is an incident going to show this to be the case. In 1885, I was connected as master mechanic with the Locomotive Trust & Improvement Company. They had an engine built at the Rhode Island Locomotive Works, having 18 × 24 in. cylinders and 57 in. driving-wheels—the engine being of the ordinary eight-wheel or American type. This engine was fitted with a traction device for throwing a portion of the tender's weight on to the engine. The "pop" valve was set at 160 lbs. In a test on the Union Pacific Railroad, this engine took 680 tons—including engine and tender—from Brookville to Mt. Zion, a distance of 16 miles, in one hour and 18 minutes. This portion of the road is a continuous grade of 70 feet per mile. Unfortunately the engine was not indicated, but with the "pop" valve set at 160 lbs., with the variations below that which would occur, it does not seem probable that the initial cylinder pressure was over 150 lbs., and it is also probable that there was a back pressure of at least 5 lbs. This would make a card as follows, giving an average effective pressure of 130 lbs. per square inch, then

$$\frac{24 \times 18^2 \times 130}{57} = 17{,}734 \text{ lbs.}$$

The resistance due to gravity on a 70-foot hill would

be $26\frac{1}{2}$ lbs. per ton and $680 \times 26\frac{1}{2} = 18{,}020$ lbs., which would make it seem that the Pambour formula is wrong because the resistance of gravity alone is greater than the pull the engine exerted on the tender draw-bar.



If it be assumed the average effective pressure was 140, which is possible, we have

$$\frac{24 \times 18^2 \times 140}{57} = 19{,}098 \text{ lbs.}$$

Gravity would use 18,020 lbs. of this, leaving but 1,078 lbs. for friction of the train or but $\frac{1078}{680} = 1.58$ lb. per ton, which is much less than has ever been recorded. If, as is usual, 5 lbs. per ton of train for resistance on a level be added to $26\frac{1}{2}$ lbs. for gravity, making $31\frac{1}{2}$ lbs. total for each ton, we have $680 \times 31\frac{1}{2} = 21{,}420$ lbs. total resistance for the train, which is more than the engine would exert if the mean effective pressure was 150 lbs. per square inch.

FRANK C. SMITH.

[The formula quoted above, does not make its own correctness as obvious as the rule for calculating the tractive power given in Clark's Railway Machinery does. That rule is, "multiply the effective mean pressure per square inch in the cylinder by the area of the piston and by four times its stroke to represent the duplicate action of two cylinders, and divide by the circumference of the driving-wheel. The result is the tractive power at the rails."

There can be no room for questioning the correctness of this rule, which s practically the same as Pambour's. But we agree with our correspondent that locomotives will often pull more than with assumed piston pressures, and the supposed resistance of train calculations will show that they should pull. This is probably due to the fact that the maximum pressure in the cylinders, when an engine is working up to its utmost capacity, is greater than that shown by indicator diagrams which are *not* taken at such times; next, the true rate of gradients and weight of trains is not always known; and third, when rolling stock and track are both in good condition there is reason for believing that the resistance is considerably less than that given in the books. It is to these reasons that the discrepancies between the actual practice and the calculation of our correspondent may, it is thought, be attributed, and not to any error in the rule quoted.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

Heating Cars.

EDITOR RAILROAD AND ENGINEERING JOURNAL: I have read an article on heating railroad cars in the JOURNAL of February, 1887, with a great deal of interest. It appears to me that this article is in the wrong in advocating stoves. In my opinion, stoves are a relic of barbarism when used for heating cars. If placed under the cars a very slight accident will break them to pieces and probably set fire to the cars. What would become of the stoves for instance, should an accident produce the position shown in Fig. 1 of the article referred to? And what could prevent the cars from being set fire to?

Steam from the locomotive seems to be the *only* safe method. Answering Mr. Depew's objection, I will say that with the Gold system cars will remain comfortable for two hours after the locomotive is detached, and for an hour with the Martin or Sewell systems. Where cars have to stand at the stations as Mr. Depew instances, what is to prevent heating the station building by the same system, deriving heat from stationary boilers which could supply heat to the waiting cars. The coupling question has already been solved by Mr. Martin, who uses no hose.

WATERMAN STONE.

THE GEODETIC WORK IN THE UNITED STATES.

MASON AND DIXON, 1764–1768.

The names of Mason and Dixon suggest to two classes of persons as many distinct ideas, together, in many cases, with a commingling that strangely represents tradition tinged with truth. The clearly defined notions are: (1) Mason and Dixon determined the length of a degree in America by measurement; (2) they located the boundary between Maryland on the one part and Delaware and Pennsylvania on the other. These are facts, but popular belief adds one or both of the following fancies: (*a*) they measured the arc from which they ascertained the degree's length while fixing the boundary; (*b*) the boundary they established between Maryland and Pennsylvania was the northern limit of slavery established by the Missouri Compromise of 1820. The first misconception will be rectified in what follows, in which it will be shown that Mason and Dixon did not mark that portion of the boundary which they measured with sufficient care to use its length for geodetic data; and the latter will be refuted when it is stated that the line agreed to in the Compromise was latitude 36° 30′, while the Maryland-Pennsylvania boundary is latitude 39° 43′ 18″, or 39° 43′ 26.3″, as found by Col. Graham in 1850.

According to the agreement made in 1732, regarding the boundary between Delaware and Maryland, a line was to be run across the peninsula from Cape Henlopen due east and west, then from the middle point of this line another should be run northward in such a manner that it would be tangent to a circle drawn around New Castle with a radius of 12 miles. From this tangent point the line was to be continued due north to a point whose latitude was that of an imaginary point just 15 miles south of the most southern part of Philadelphia. Law suits and other sources of delay followed, so that it was not until 1760 that commissioners were appointed, who ran the line across the peninsula, determined the middle, computed the point of tangency and ran the tangent. As the entire line was through dense forests, it was necessary to cut out sight-lines or vistas, making the work so tedious that three years were consumed in accomplishing the part just mentioned. The proprietors, who resided in London, became so impatient that they decided to send surveyors from England to complete the undertaking, and to verify what had been done. The persons selected were Charles Mason and Jeremiah Dixon. They arrived in Philadel-

phia. Nov. 15, 1763, and began work by erecting a small wooden observatory at the most southern point in that city. Here they observed for latitude, using a sector of 6 feet radius constructed by Bird, which Maskelyne said was the first to have the plumb-line passing over and bisecting a point at the center of the instrument. During the following spring, while testing the lines run by their predecessors, they noticed that the tangent line was almost due north, and the character of the ground such as to make it quite easy to measure the line with the accuracy that would allow the results to be used in ascertaining the length of a degree. Also, that the amplitude could be found by simply observing for latitude at one additional point, having already determined the latitude of the northern end of the arc in fixing the point from which the west line between Pennsylvania and Maryland was to start.

It is probable that Mason and Dixon received their inspiration to perform this geodetic work from Boscovich, whom they may have known in London during his stay there in 1760. Boscovich had been elected a Fellow of the Royal Society, in consideration of his degree measurements in Italy from 1751 to 1753, and Mason and Dixon, while in the swamps of the peninsula, might have seen along the vista in which they were working the coveted way to become, as De Morgan said, a Fellow Really Scientific; at all events, each became an F. R. S., in consequence of this very undertaking.

They represented to Maskelyne, who was then Astronomer Royal, the advantages this line offered for accurate measurement, and indicated their willingness to take charge of the work at the Society's expense. On Oct. 24, 1764, the Council of the Royal Society resolved that the precise measure of a degree of latitude in America, in the neighborhood of Pennsylvania, appears to the Council and to the Astronomer Royal, who was pleased to assist on this occasion, to be a work of great importance, and that the known abilities of Messrs. Mason and Dixon, the excellence of the instruments with which they are furnished, the favorable level of the country and their assistants well practiced in measuring, do all concur in giving good ground for hope that the business may now be executed with greater precision than has ever yet been done, and at a much less charge than the Society can reasonably expect an opportunity of doing hereafter.

"*Resolved*, to employ Messrs. Mason and Dixon in the said admeasurement of a degree of latitude, and to allow them the whole of their demand, being the sum of two hundred pounds sterling for the said work; and also, in case the proprietors of Maryland and Pennsylvania should refuse their stipulated allowance for their passage home, but not otherwise, the further sum of forty pounds, for the said passage." A resolution was adopted requesting Maskelyne to draw up the instructions for their guidance. These were sent together with a brass standard of 5 feet, with which the measuring rods were frequently to be compared, and the difference noted, and also the height of the thermometer at the time.

Work on the Pennsylvania–Maryland boundary was stopped, 15 miles before the terminus was reached, in 1767, by the Indians, who said it was not the wish of the chiefs that a certain war-path should be crossed, so Mason and Dixon returned to Philadelphia, and at once prepared to make the measurement so encouragingly endorsed.

While testing the line they intended to measure it was found that the alignment was practically perfect, leaving nothing to be done but to determine its length and amplitude. The apparatus they devised for measuring they called levels, because they were placed in a level position when in use. As the ground was not perfectly horizontal, the apparatus was so constructed as to make contact on different planes. The levels were each 20 feet in length and 4 feet in height, made in a rectangular form of inch pine. The breadth of the bottom board was 7½ inches, that of the top, 3 inches, and the end pieces, 4½ inches, while the bottoms and tops were firmly strengthened by means of boards fixed to them at right angles. The joints were secured with plates of iron, and the ends plated with brass. They were set level by means of a plumb-line, 3 feet 2 inches long, suspended in the middle, the point of the plumb-bob bisecting a given mark in the bottom; the plumb-line was hung within a tube, so as to be free from the action of the wind. If the frames were true rectangles every point in the ends would be in the same vertical when the top and bottom were horizontal. In case the ground was irregular one end of the level was raised by a "winch and pulley." Just how this was done is not stated. When a level was put in position, a short stake was driven in the ground very near and opposite the plumb-line, in the top of which moved a thin iron plate, about 12 inches long. In both ends of this plate there were points that could be directed toward the intersection of cross lines on the frame.

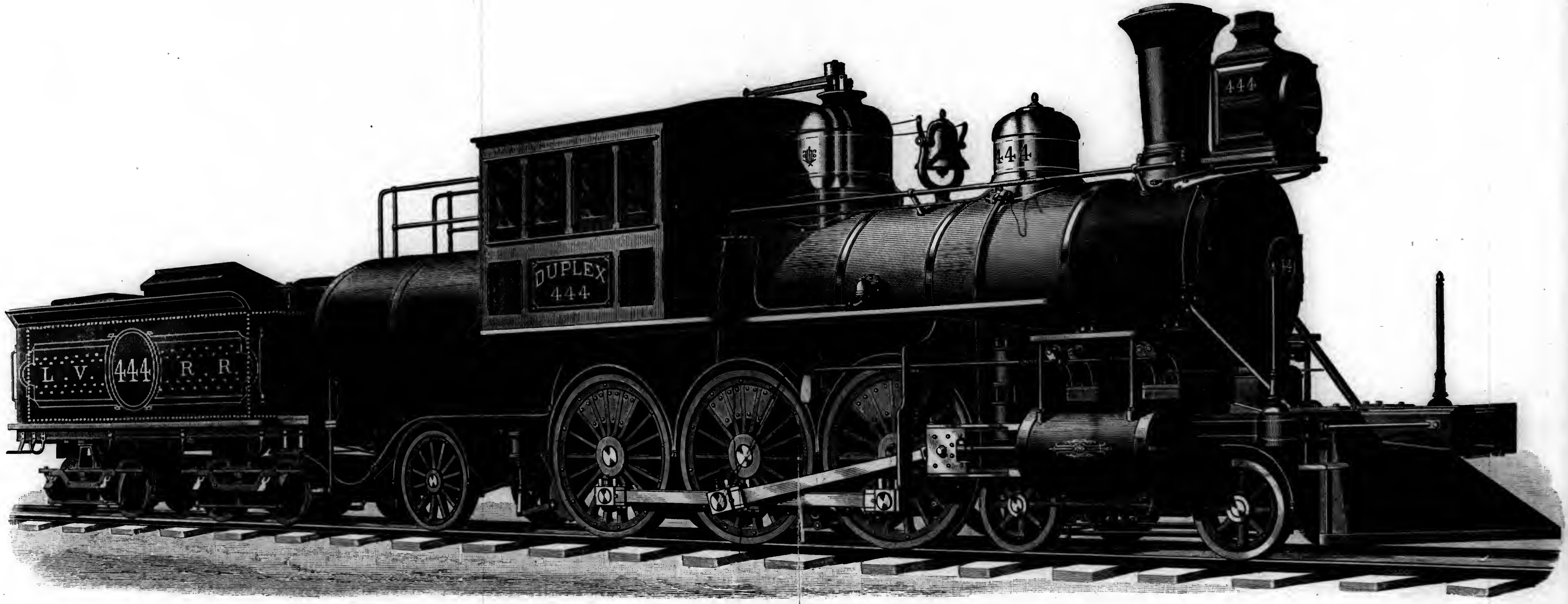
By bringing these points into line with the intersection, the level could be placed in its former position if moved while making contact. One level was set and marked, the alignment being effected by sighting along the top to the point made by the apparent convergence of the sides of the vista, then another level was placed in front, adjusted and marked, when the rear one would be brought forward, and so on. Record was kept by stretching, in a line parallel to and quite near the levels, a rope equal to 12 times the length of one of them, and the number of rope lengths recorded. The mile-stones placed by the first surveyors also served as checks upon the count.

The levels were frequently compared with the brass standard, provided by the Royal Society, and the difference between the lengths of the two levels and 8 times the standard was noted, together with the temperature at the time of comparing. At the ends of the bottom boards of each level there was attached, in the direction of their length, a piece of brass on which a fine line was drawn a tenth of an inch of the end. The last tenth of an inch of the standard was divided into hundredths so that, by means of a magnifier, the difference between 8 times the length of the standard and the two levels could be quite easily ascertained. The standard temperature was 62° F, that being the temperature previously adopted in comparing, and the coefficient of expansion for brass, .0000108 was taken from Graham's determinations.

Streams were crossed by measuring a short base and putting the distance from a point on one bank to another on the bank opposite, from angles observed with a Hadley quadrant.

The azimuth of the tangent line was found by observing Ursa Major on three evenings to be 3° 43′ 30″.

A B = 434,011.64 ft., referred to brass standard at 62° F. Supposing that t is the point in which the great circle passing through B cuts the meridian A M, then regarding A B t as a right angle, they computed A t. In



THE STRONG LOCOMOTIVE "DUPLEX."

BUILT IN THE SHOPS OF THE LEHIGH VALLEY RAILROAD, AT WILKESBARRE, PA.

ALEXANDER MITCHELL, *Division Superintendent and Master Mechanic.*

doing this they regarded the triangle as plane, thinking that the smallness of the angle at A and the shortness of the sides as compared with the radius of the sphere would not change it greatly from a plane triangle. This gave A *t*, 433,094 ft., and they then subtracted R *t*, the distance of the great circle from the circle of parallel which they found to be 15.8 ft.

The corrected value for A R = 433,078.8 ft.; N P, by measurement, at 62° F. = 78,290.7 ft.; C D, by measurement, at 62° F = 26,608 ft.; D G, by computation (C D M = 86° 32½′, nearly), = 89.7 ft., giving as the distance between the parallels of A and N = 538,067.2 ft.

The amplitude of the arc from difference of zenith distances as measured with the sector referred to was 1° 28′ 45″. The latitude of N was ascertained previously to be 39° 56′ 18.9″, which gives 39° 11′ 56″ as the average latitude, at which point from linear measurement and amplitude 1° = 363,763 ft.

It was assumed that the French foot was to the English foot as 114 to 107, which gave for a degree 56,904.5 toises. The accuracy of this equivalent depends upon the temperature of the standards during comparisons; the toise being iron and the five-foot bar brass, their different rates of expansion would give them different lengths at varying temperatures. The temperature to which all the measurements were reduced was 62° F., but it is not known that this was the temperature of the French and English standards while being compared.

After the completion of the measurement the five-foot bar was again adjusted to the Royal Society standard, when it appeared that the length of the arc was too long by 13 feet. "It is probable that the length of a degree has been taken 10 or 20 feet too short by placing the point C too far to the southward, which would about balance the small correction in question." Just what reasons they had for supposing this is not mentioned. Likewise a new comparison was made, using the *toise de perou*, which gave for a degree, 56,888 toises. There seem to have been two copies of this toise of slightly different lengths, and it may be that the same one was not used for the two comparisons. The latter value is the one most frequently quoted.

The actual value of this work has received various estimates: Maskelyne considered it a valuable addition to the measures of degrees, especially as the level character of the country to the north and south of the line rendered a deflection of the plumb line improbable. Cavendish, on the other hand, suggests that the Allegheny Mountains may have shortened the degree by 60 or 100 toises. Airy thought it accurate enough to be used in determining the figure of the earth, as did also Schubert, Listing and Laplace. Bessel did not embody this arc in his discussion, so its influence is not felt in his resulting constants. A degree in the latitude in which this measurement was prosecuted, according to Bessel's formula, is 56,956 toises, being 51.5 toises longer than Mason and Dixon's first value, and 67 longer than their second—a discrepancy greater than exists between any other northern measured and computed degree according to Bessel. Clarke also omitted this arc in his investigation, his formula gives this degree 467 feet or 73 toises longer than they found it.

If the measurement and amplitude of this arc be trustworthy, it shows that, on the hypothesis that the earth is a solid of revolution, that Bessel's spheroid is more nearly correct than Clarke's, since it gives a smaller discrepancy. But in the work of the U. S. Geodetic Survey it has been found that the use of Clarke's spheroid makes the station error a minimum, from which we can infer that the work of Mason and Dixon had but little merit. Their measurement may have been accurate, throwing the error upon the deflection of the plumb-line.

However, we must wait until we have arcs in the Western Hemisphere good enough to have a voice in determining the figure of the earth before we can definitely decide regarding the character of this, the first geodetic operation in America.

The Speed of War Vessels.

The New York *Herald* says "The most noticeable feature of the Senate bill for the construction of steel cruisers is the high speed which these vessels are expected to develop. Less than four years since 15 knots were gladly accepted as a maximum beyond which profitable naval design could not be urged. Greater speed, it is true, had been attained by our first type of commerce destroyers, but there was a general appreciation that the *Wampanoag's* performance could not be accepted as a useful standard, because she was in essentials not a man-of-war, but a mere racing machine,

"To-day, without any undue public astonishment being excited, effective fighting ships are called for wherein every quarter of a knot below 20 miles pays a penalty which, at our former summit of expectation, would have been prohibitive to ship construction. And, what is more startling yet, the bonus which equally goes to any increase upon this speed proves how great is the correlation between scientific attainment and popular appreciation, and how readily the impossibilities of yesterday become the axioms of the morrow.

"Wherever specialists may differ upon other questions of naval construction, there is a universal agreement as to the value of high speed, this element being deemed equivalent to that vaunted weather-gage of the old days which enabled the swifter ship to choose its range and relative position, and to force or avoid an action.

"The growth of this speed development is, therefore, not without interest. Briefly generalized, it may be said that between 1859 and 1875—that tentative period which led to such wonderful realizations—the highest speed under the most favorable circumstances of large vessels was 14 knots. In the smaller classes of unarmored ships it ranged between 8 and 13, while that attained by fast cruisers was from 15 to 16½ knots.

"In the last year Italian armored vessels of over 13,000 tons displacement accomplished over 18 knots, and cruisers, like the Japanese *Naniwa Kan* and the Italian *Angelo Emo*, have reached 20.

"Torpedo boats, which in 1873 began with 14 knots, have now steamed 25, and at the same time this type has increased so materially in size and importance as to have become, not an accessory, but an essential in naval warfare.

"What has been done abroad the *Herald* believes can be more than attained here, and should the present bill become a law it does not doubt that American inventive genius, profiting by the failures and successes of foreign constructors, will produce a type which will revolutionize naval ship construction everywhere."

The Strong Locomotive "Duplex."

THE large illustration given in this number is from a photograph of the locomotive "Duplex," No. 444, recently completed at the Wilkesbarre shops of the Lehigh Valley Railroad. This locomotive is of the Strong pattern, to which some reference has heretofore been made; it has 20 × 24 inch cylinders and six 62-inch drivers. The

Fig. 1.

M. N. FORNEY'S IMPROVED CAR SEAT.

boiler has two fire-chambers. each consisting of a corrugated steel flue, both being joined at the forward ends in a single combustive chamber.

This engine is now at work running passenger trains over the heavy grades of the Mountain Division of the road. Some account of its working, with a detailed description of the engine, will be given hereafter.

M. N. FORNEY'S CAR SEAT.

THE engravings herewith represent the latest form of an improved car seat designed by Mr. M. N. Forney. Fig. 1 is a perspective view, Fig. 2 a front elevation with a section through the side of the car and window, and Fig. 3 an end view with the seat end removed.

5. The backs can be reversed in less space than those ordinarily used. The motion is much easier, and there is no tendency to come down with a "bang" when they are tnrned over carelessly.

The mechanism employed to effect these ends is shown clearly in Fig. 3, in which the seat-arm or "end" is removed. The back B' and seat S' are represented by full lines in the position they occupy when the back is turned half-way over. These parts are also shown by dotted lines in their two reversed positions. The back has projections D' and E, E' and D which, when the back is turned over, alternately support the lumbar region or "small of the back" and the head and neck of the occupant of the seat.

The seat-back is reversed from the one position repre-

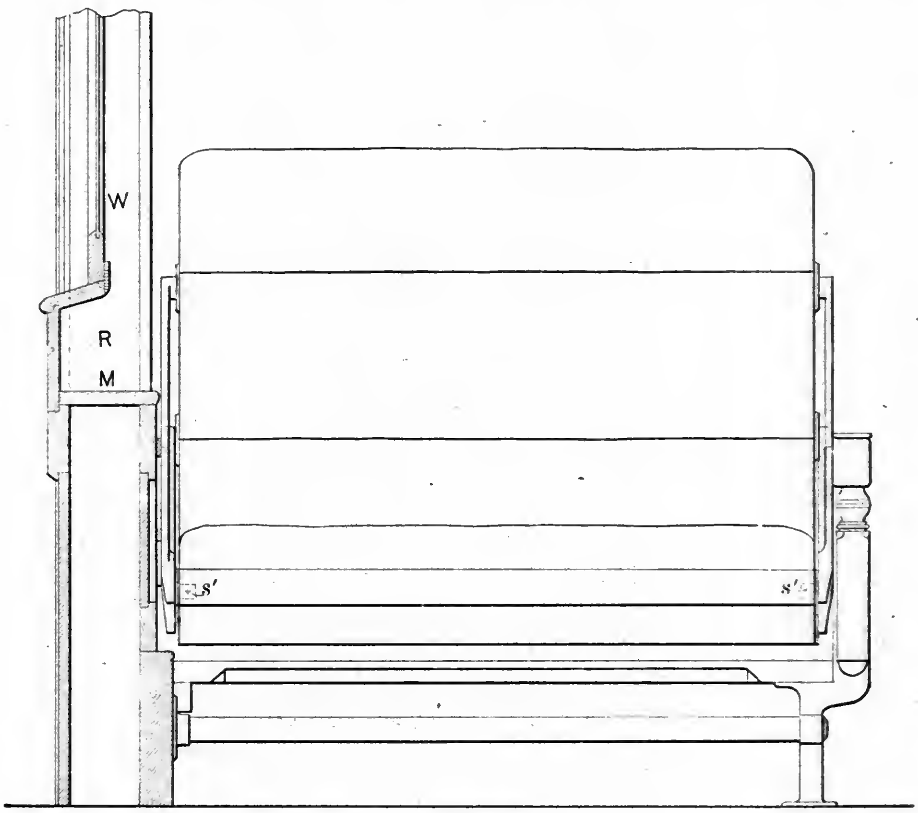


Fig. 2.

The following are the advantages which result from the method of construction shown by the engravings:

1. The backs can be made of any desired height, so as to give ample support for the heads of passengers.

2. While the backs can be as high as required, their lower edges do not come below the tops of the seats, so that there is more room between the front edge of each seat and the back than there is with ordinary seats.

3. The seat-backs have projections which support the lumbar regions of the spine or the "small of the back," where support is most needed to prevent fatigue while in a sitting posture.

4. The seats are made to incline backward, so that the jolting of the car has no tendency to cause their occupants to slide off of them and away from the backs. Very little muscular effort is therefore required to maintain a sitting posture, so that persons can rest or sleep in these seats almost as comfortably as they can lying down. The inclination of the seats is reversed when the backs are turned over.

sented by the dotted lines to the other by means of two pairs of crossed links, or arms, L L'—one pair at each end of the seat. These are connected to the seat-end and side of car by fixed pivots P P', and to the seat-back by other pivots, p p'. The links project below the fixed pivots P P', and each of them has a projecting pin or stud s s' (shown by dotted lines in Fig. 2.) which support the seat. The seat or cushion-frame has slots n n' in each end which receive the pins s s'. These slots allow for the variation in the distance apart of the pins which occurs when the back is reversed. The action of these links will be readily understood if we follow the movement of the back from the position shown by dotted lines at B, Fig. 3, to the position when it is turned half way over, represented in full lines, and finally to that indicated by dotted lines at B'', when the back is completely reversed. The dotted lines o p q and o' p' q' represent the paths in which the pivots p p' move when the back is reversed, and r s t, r' s' t' are the paths which the lower pins or studs s s' describe during the same period. It

will be seen that when the back is reversed from the position shown at B to B'' that the pin s moves in the arc $t\ s\ r$, and s' moves from t' to r'. When the back is in the position B the seat is in that shown by the dotted lines at S'', and it is then supported on the pins at $t\ t'$; with the reversal of the back these pins are moved from t to r and from t' to r'. The seat then occupies the position shown by the dotted lines S. It will be seen that, by reversing the back, the seat is moved horizontally; and its inclination is also reversed, so that in both positions of the back it inclines backward, which adds materially to its comfort. If the seat is not moved horizontally when the back is reversed, more room lengthwise of the car will be required for each seat of a given width and a back of any desired form or inclination. With this mechanism for reversing the backs they can be made of any required height, and, as appears from the illustrations, their lower edges come above the tops of the seats. This leaves the space behind the seat entirely clear, so that with seats of this kind there is more room than with those ordinarily used.

It will also be seen that the fixed pivots P and P' are located on a line with the top of the seat. With the

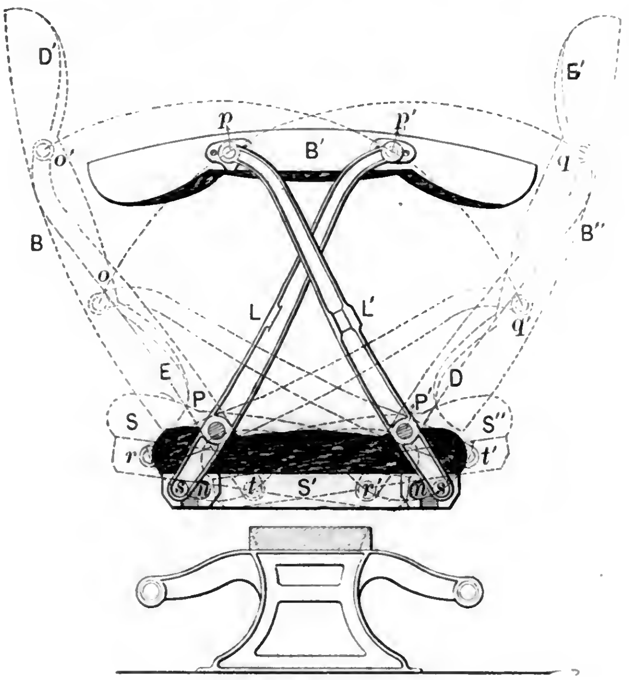


Fig. 3.

ordinary method of reversing backs, the pivot about which it turns must be placed so far above the seat that it elevates the arm-rest at an uncomfortable height, so that the shoulders of passengers are raised up into an uneasy position. The location of the pivots $P\ P'$, shown in the engravings, permits the arm-rests and window sills to be lowered to any position that will be most conducive to comfort. The fact that the arms of drawing-room car chairs are always made much lower than those of ordinary car seats is evidence that the latter are too high. But if the window sills are lowered so as to be of the most comfortable height for arm-rests, there is danger when they are open that persons will put their arms or feet outside and be hurt, and children standing up in the seats may fall out. For these and other reasons, the method of construction shown in Figs. 1 and 2 has been devised. The window ledge M, Fig. 2, has been placed 24 in. above the top of the floor. This is just about the height of a drawing-room car chair arm. Under the window W, a recess or pocket R is constructed, which is flush with the outside of the car. This makes the ledge M wide enough for a comfortable arm-rest, or it can be used as a shelf to hold books or packages. As shown in Fig. 1, the crossed arms come so low down that they are not in the way of a person occupying the seat, and as the recess or pocket R gives sufficient room for the arm of a passenger, he or she can sit close up to the side of the car without discomfort. The result is that in effect, the seat, crosswise of the car, is, with this arrangement, practically lengthened three or four inches. When the windows are up, there is little liability of passengers putting their arms outside of the car, because the recess gives them a more comfortable rest than the window sill above it does. The window recess and this form of seat together, it is thought, will give more room and comfort to passengers than any other arrangement yet devised. Railroad companies or others wishing to use either or both of these devices can address M. N. Forney, 23 Murray Street, New York, for further information.

King's Compound Engine.

(From *Engineering*.)

THE compound engine which we illustrate above represents a new method of construction lately introduced by Mr. H. J. H. King, of Newmarket, near Stroud, Gloucester. In this arrangement the high-pressure cylinder is placed immediately above the low-pressure cylinder, and both of the pistons work on to the same crank-pin through the intermediary of the same connecting-rod. This rod is made in the form of a triangular frame; at one corner it is pivoted to the cross-head of the low-pressure piston, while at the corresponding upper corner it is connected by a long link to an extension of the high-pressure piston-rod. The details of the arrangement are shown in Fig. 2, where it will be seen that the latter piston-rod is cottered to a slotted frame, which also serves to transmit the motion to the air-pump. Inside the slotted frame there works a link, which at one end is pivoted to the frame, and at the other to the triangular connecting-rod. At the apex the connecting-rod works on the crank-pin in the usual way, and transmits to it the power of the two cylinders.

In this particular engine the main valves of the high and low-pressure cylinders are worked by a single eccentric, 1 (see Fig. 2), the rod 2 being taken off at the proper angle to give the right lead to the high-pressure valve. The rocking-arm 3 is centered on the stud 4, and, being of considerable length, the pin 5 moves practically in a straight horizontal line, so that the rocking-arm forms a guide for the high-pressure valve spindle 6.

The expansion valve, which may be automatic or otherwise, consists of a gridiron valve working on the back of the other. The automatic arrangement is shown in this case in dotted lines. The end of the expansion valve spindle is carried by the rocking-arm 7, and the link 8 is moved by the governor. The rod 9 is centered on the pin 10, and 11 is worked by an eccentric, 12, shown in broken lines.

This engine, which we illustrate, is working at Bliss Saw Mills, Chalford, and was formerly a high-pressure engine, with 9 inches cylinder, 20 inches stroke. The fuel pre-

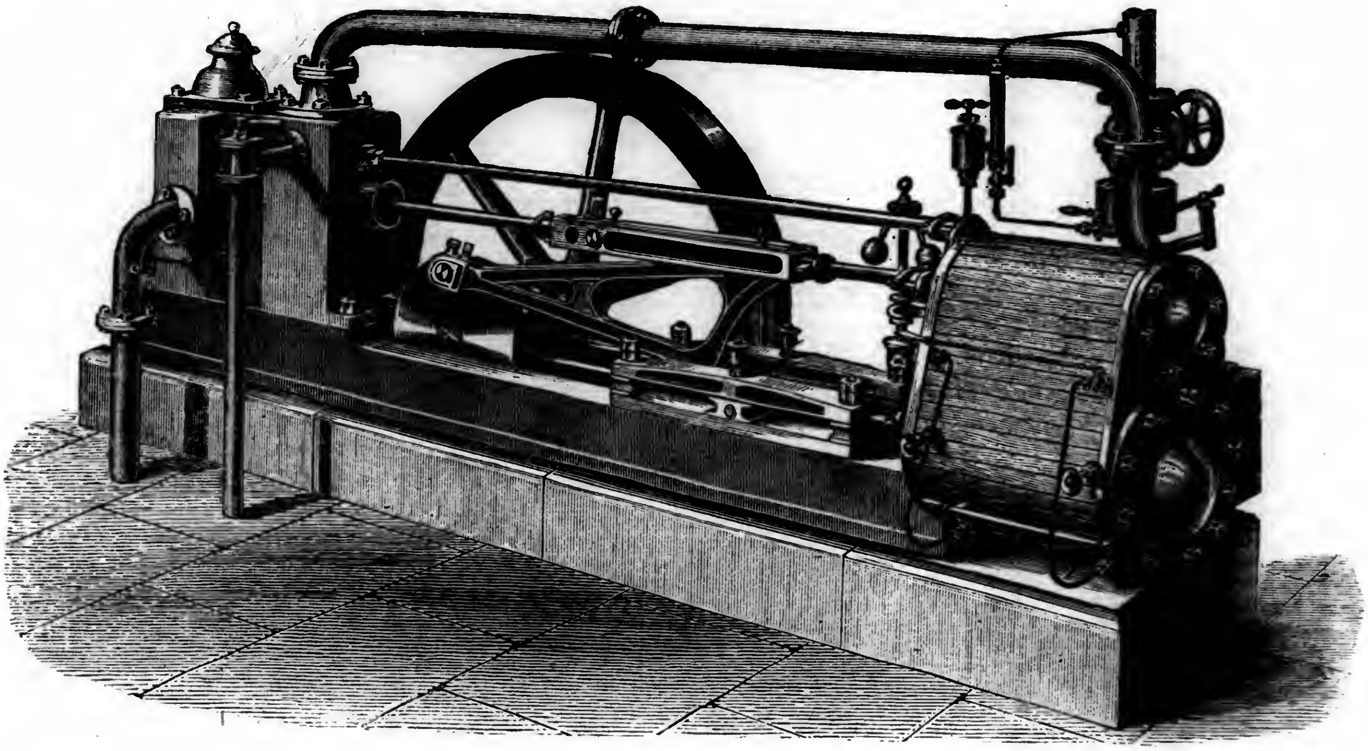
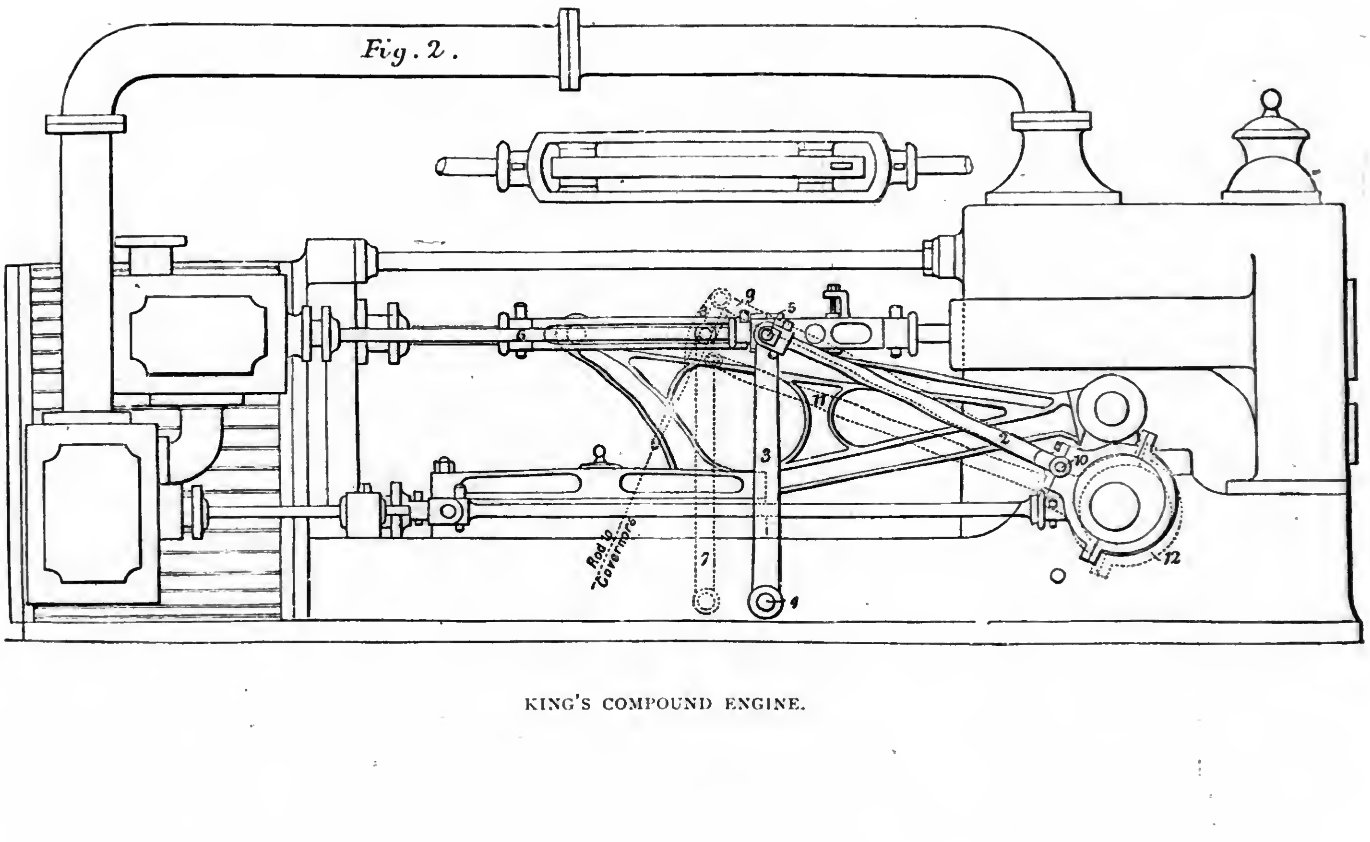


Fig. 1.

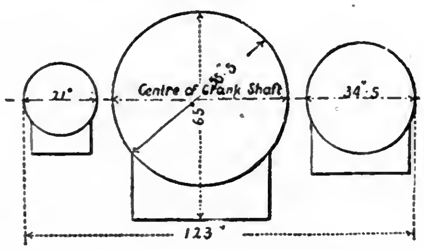


KING'S COMPOUND ENGINE.

viously used was wood, shavings and coal. Now the whole of the coal, except the small quantity required to get up steam, is saved. Mr. King is also making two more engines of the same design for the same firm, with cylinders 13 inches and 24 inches in diameter.

It must be conceded that this is a most ingenious and novel design, and that it offers considerable advantage, particularly in compounding existing engines. The engine will start in any position, the steam passages are extremely short, and all the parts are perfectly accessible. The space occupied is very small, and if the air-pump be brought

Fig. 3.



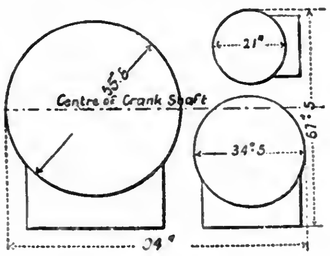


Fig. 4.

nearer the cylinders, does not exceed that of an ordinary high-pressure engine. Figs. 3 and 4 annexed show, as an illustration, the space occupied by a triple-expansion marine engine, first with the cylinders placed as they now usually are; and, second, as they would be if arranged on Mr. King's system, and working on two cranks instead of three.

Foot Bridge for English Railway Stations.

THE engraving on the opposite page represents a form of bridge which is used a great deal at the smaller stations in England. In that country passengers are not allowed to cross the main line, to avoid which a bridge or subway is nearly always provided to enable passengers to cross from one side of the line to the other. The engraving is copied from an advertisement of Messrs. Arrol Brothers, of Glasgow, and it is thought that it will be of interest to many railroad engineers in this country, as an example of the common practice in Great Britain for securing greater safety to travelers. There are many stations in this country where such bridges should be provided, and as traffic increases, crossing bridges of this character will become much more common in this country than they have been heretofore.

Iron Ore Contracts.—In Cleveland, which is the leading market for Lake Superior ores, an active demand is reported, especially for Bessemer ores. Good authorities estimate that contracts have been made for 3,000,000 tons for the season. Naturally, prices are high, and freights by lake are firm also. At Cleveland, specular and magnetic Bessemer ores are quoted at $7 per ton; specular (non-Bessemer) ores, $6; Bessemer hematites, $5.75 @ $6.50, and other hematites $4.50 @ $5.75 per ton.

Selected Articles.

Electric Street Cars.*

THE great question agitating street-railroad companies in this country at the present time is the use of some motive agency more economical and convenient than horses. It is no exaggeration to say that, after about half a century of patient trial, they have become profoundly dissatisfied with animal power and are ready to adopt any system that can establish its claim to their preference.

The struggle for supremacy in this field of occupation may fairly be said to have narrowed itself down to three competitors—the horse, the cable and the electric motor. Steam used directly seems to be viewed with more and more disfavor as the years go by, and has, within city limits, come to be considered very much in the light of a nuisance. The lowest cost of operation per steam motor per day in usual service, quoted authoritatively, is $8.50 to $7. But even if steam were cheap, there are grave objections on the score of noise, smell and dirt. The mere fact that steam locomotives have been in successful use 50 years, but are still denied employment on the streets, tells its own story as to public opinion. To some of us the banishment of steam even from the tracks of elevated roads seems a matter of but a few years. As for gas, soda and compressed-air motors, the writer is not aware that they offer any points of superiority over steam for the specific purpose under discussion.

Coming to horses, we find that, in spite of their universal use and their faithful performance of duty, they inspire a discontent anything but complimentary, yet hardly to be wondered at. The statistics of horse-cars are important and interesting, and deserve our attention as covering the sphere within which the electric motor will operate There are, according to the latest returns available for this year, about 625 street railroads of all kinds in the United States and Canada. Taking 408 horse roads giving full and trustworthy figures, it is found that they run 17,331 cars and employ 85,888 horses. If, at the same ratio, we took all the horse roads, upward of 500, we should arrive at a result of not far short of 25,000 cars and 120,000 horses, a total that probably comes very near the actuality. Taking the other figures, tested by three sources of information, it appears that all the horse-car lines are maintaining a proportion of at least five horses to each car. But that is inclusive, and making a reasonable allowance for the use of different cars for winter and summer, and for idle cars, as well as for doubling up in heavy snows, a result is shown of at least eight to ten horses per car. This is the proportion usually cited, and it is brought out on a special examination of the statistics for New York City.

The conclusion reached is that the cost of horse power for a car is not less than $6.50 per day with horses. To this cost is to be added the necessary expense of large stables, requiring an extensive investment in real estate and buildings, and the cost of replacing horses, whose average life at this work is not over five years.

The cable system is open to two objections, its large first cost and the small part of the power actually used in moving the cars. Figures produced in this paper make

* Abstract of paper read by Mr. T. C. Martin, before the American Institute of Electrical Engineers at its December meeting.

the cost of a cable railroad about $50,000 per mile of single track, putting it out of the question for roads of moderate traffic. Other figures are given from actual experience with cable railroads, which would show that from 68 to 80 per cent. of the power is required to move the machinery and cables, leaving from 32 to 20 per cent. actually utilized for the movement of the rolling stock. At the best, this system is only available where the traffic is sufficient to pay interest on a heavy first cost.

This leaves the field open to the advocates of electric railroads, whose case is fairly stated in this paper.

There are four leading systems of electric motors which are considered in order, as follows:

1st. The third-rail system.
2d. The overhead conductor system.
3d. The conduit system.
4th. The storage or secondary battery system.

1. The third-rail system is represented by two roads in actual operation, one a suburban line, on the Daft system, in Baltimore, and the other the Highland Railroad in Detroit. The Baltimore line is now in its second year of operation; it is a road with comparatively light traffic and has so far been very successful. The cost of power is reported at $4 per car per day, against $6.50 for horses. The road has been so successful as an investment that an extension is now under construction. The largest item in expenses is fuel, coal costing $3.50 per ton.

The Highland road in Detroit is also a line of light traffic; it is a much easier line to operate than the Baltimore road, being free from steep grades and sharp curves. It is three miles long, and has been so successful that plans are arranged for an extension.

The conclusion reached is that the third-rail system must be limited to a low electromotive force, and is best adapted to suburban lines of light traffic.

2. Of the overhead conductor systems the Van Depoele systems form an important group. These roads are now in operation at Detroit, Mich.; Port Huron, Mich.; Windsor, Ont.; Appleton, Wis.; Montgomery, Ala., and Scranton, Pa. In these systems the feeding conductor is suspended by side poles, or, as at Appleton, has double wires corresponding to the track, but immediately above it at a height of 18 or 20 feet. The Appleton road, which has five cars, is run by water-power, having a pair of turbines which will develop 100 horse-power and are now running a 60 horse-power dynamo. The Montgomery road is notable as being a complete city system, having 10 miles of track. The Scranton road which started in January has two features of special interest. One is that in a city of nearly 60,000 people an overhead conductor is allowed; the other is that the line is operated from the electric-light station. The road is 2½ miles long and has 12 grades, most of them 6 per cent. There are in use two heavy cars running at a speed varying from 4 to 15 miles an hour. The current is conveyed by a conductor 0.3 inch in diameter, the rails forming the return. A traveler with rollers and a flexible cable passes the current to the motor, which stands on the front platform in sight of the driver. The electric-light station receives $9 per day for running the 60 horse-power generator, and an increase in rolling-stock will involve very little increase in cost of power.

FOOT BRIDGE FOR RAILROAD STATIONS.

MADE BY ARROL BROTHERS, GLASGOW, SCOTLAND.

Under this head also should be included two new roads built by Mr. Daft at Los Angeles, Cal., one 3½ and one 2½ miles long. On these roads the motor is placed in the center of the car, taking the room of two passengers.

The overhead conductor system is necessarily limited to currents of low electromotive force, but, like the third-rail system, may be employed in places where the expense of a cable system would be out of the question, and even horses could not be made to pay.

3. The first exemplification of a conduit system in this country was given by the Bentley-Knight Electric Railway Company, in 1885, at Cleveland. A working section of their line can now be seen at the Rhode Island Locomotive Works, and as it illustrates in a striking manner the principles involved, a few of the leading points, now described for the first time, are touched on. The conduit is made to resist the heaviest wear and strain of street traffic. The surface opening or slot is only ⅝ inch wide, and the total width of metal at the street surface is but 3 inches. The conduit is kept clean by a broom of peculiar shape suspended from the car. This broom is said to have swept out in a single trip the accumulation from 12 hours' constant snowing. At convenient points catch-

pans with sewer connections receive the sweepings and effect drainage. The two main conductors consist of channel iron connected by expansion joints and lined with a continuous strip of copper of sufficient size to carry the current with but small loss of energy. These conductors are fastened to the side walls of the conduit on insulators of vulcanized wood dipped in white lead. The insulators are strongly set in sockets in the cast-iron supporting yokes. Neither the traffic rails nor the conduit structure form any part of the electrical circuit. To provide for switching, a movable tongue is pivoted at the point of branching, so as to rest on the top of the conduit and to be readily set to close either of the branch slots and direct the contact plow into the other. A corresponding conductor tongue within the conduit is moved at the same time. The contact plow for making connection consists of a flat frame hung from the car by transverse guides, on which it is free to slide the whole width of the car, and extending thence down through the slot of the conduit. It is provided with a swivel joint, so as to adjust itself to all inequalities of road or conduit. This frame carries two flat, steel, insulated conductor cores, to the lower ends of which are attached, by a spring hinge, small contact shoes of chilled cast-iron that slide along in contact with the two main conductors. At the upper ends are flexible connections leading to the motor. This plow can be inserted or withdrawn through the slot at will, the spring hinge allowing the contact shoes to straighten out into line with the conductor cores when the plow is pulled upward and the shoes strike the insulating lining with which the slot irons are provided. By no accident, therefore, can anything be left behind in the conduit to obstruct succeeding cars. The plow guides are hung on transverse axes, and are held in a vertical position by a spring catch that gives way when the plow meets an irresistible obstruction, and hence the plow is automatically thrown completely out of the conduit without injury, being also immediately replaceable. The contact shoes will stand weeks of wear, and cost next to nothing. The frame of the plow has wearing guards of hardened steel wherever it can touch the edge of the conduit slot, and these are also readily renewed. Two plows are used on each contact for the sake of absolute reliability, and to prevent flashing at the contact. The connection between the wheels and motor consists of a system of gear wheels and connecting-rods, the gears being deadened so as to be quite noiseless. The company makes a completely equipped steel-framed truck, with motor, etc., upon which can be placed any car-body. These have a wheel-base of 6 feet, a standard gauge of 4 feet 8½ inches and can be used on curves with a radius of 45 feet A motor of the Gramme type is used under the car. For long distances, the motors are in series with current constant; for short distances, the motors are put in multiple arc and a new form of resistance is used.

An estimate of the cost of this system for an existing road in New York City, 3¼ miles long, double track, with very heavy traffic (cars to run 1½ minute headway), maximum grade 3 per cent., and cars running night as well as day, was, for first cost of plant, $213,830; running expenses and interest on cost of plant, $39,320 yearly.

The conduit system of Mr. Wm. Schlesinger has been in use for some months by the Union Electric Company, in Philadelphia. It consists of two conduits, the upper of heavy channel iron for connection, the lower of wood or cement for drainage. To insulate the conductors, an angle iron is riveted to the top flange of the channel iron in such a manner that one of its flanges, pointing downward, parallel to the main side of the channel iron, forms one side of the slot. In the inverted trough thus formed the copper-bar conductors are fastened, the contact being on the under side. Against the conductors, pulling upward, rub or press springs, making a firm, close contact under control by means of a frame holding the springs. In this system the motor is under the car between the axles and geared to them by chains. The motors are intended to work in multiple arc.

It is claimed that in the conduit system the net return of power reaches from 50 to 60 per cent., while the first cost is only about half that of a cable road. A feature of the conduit system is that it is the only one with which high potentials can be employed on the streets. With it, also, the power stations can be placed near ample water supply or where rents are low, or can each be given a section of road to operate.

4. The storage or secondary battery system, though not favorably regarded by some electricians, has been successfully tried. It is stated that this system is to be extensively used at an early date by the North Metropolitan Tramway Company, in London. At Antwerp, in 1885, after six months' competition with four other cars using either steam or compressed air, the Julien electric storage car took the first prize, awarded by a jury of well-known experts. There were in all 23 points of comparison. The Julien car has since been tried in Hamburg, and another has been in operation on the Eighth Avenue line, in New York. It will be admitted that there are advantages in having each car an independent unit, offsetting the disadvantage of carrying the dead-weight of batteries; and that single cars on any road can be taken in hand for change, so that existing rolling-stock can be progressively adapted to the new conditions. This involves a smaller initial outlay and gives opportunity to train the present force in its unfamiliar, though simple duties. Now, regarding first cost, it has been said that two sets for an ordinary street car would cost about $1,500. That seems high. The Julien Company states that the cost of the horses for a car more than covers the initial outlay of the change; the estimate is also made by the company of a total daily running expense of not to exceed $5 per car in cities on heavy traffic. As to life of the batteries, those in the Hamburg-Julien car have been in daily use since April, and they show by test a return of more than 80 per cent. of the power with which they are charged. The car is running on regular daily service. In respect to American storage batteries it may be mentioned that the Electrical Accumulator Company, whose officers have a standing in electrical circles, guarantees two years' life for its new battery and an 80 per cent. return of power. The criticism has been made that ordinarily 20 per cent. of the stored energy is retained on each emission, but, obviously, that is no loss, forming simply 20 per cent. of the succeeding charge.

It is thought that a number of efforts will shortly be made in the direction of using secondary batteries for regular work on street cars, and the result will merit the most careful study. There are, moreover, some ingenious propositions for combining the conduit and storage systems, so as to enjoy the benefits of both. Mr. J. M. Pendleton has described a plan of his of this nature,

and Mr. Elias Ries, of Baltimore, has also carefully elaborated such a system, in which storage plays an important part.

Mr. Martin concludes his paper as follows: "Here, then, illustrated in a variety of ways and by numerous examples, we have a comparison of electricity with other power for propelling street cars, and an idea is given, very imperfectly, of the wide range of choice that electricity itself offers as to methods and means. Much of what has been said has its direct and favorable bearing on elevated railroad traction, as well as on that for underground railways, but the time will not permit me to pursue the subject any further. Many points of discussion arise as to the connection of the car axles with the motor; the use of independent motor cars or of motors on the passenger cars; the types of motors and of conduits or conductors; the potential that is safe under certain conditions; the methods of regulating motor speed; the use of resistances; but all these and others I may leave to you, many of whom are doing practical and creditable work in this field, and who, by thus 'hitching your wagon to a star,' have shown that street cars, if run by electricity, may yet be brought up to the most advanced notions of humanity, comfort, convenience and economy.

"All that remains is to press onward and occupy the preëmpted territory that awaits us. As Emerson says: 'Our duty is plainly not to throw ourselves across the track, not to block improvement, not to sit still till we are stone, but to watch the uprise of successive mornings and to conspire with the new works of new days.' This sentiment may surely be appropriated by modern electricians, who every year put their skill to some severer test, and every year win fresh triumphs. In beginning this street-railroad work, we may count on a large and profitable travel for some time to come through the mere novelty of the thing, but as the art improves it will more and more manifest its right to street-railroad propulsion on the strictest business principles, as well as on every other ground of merit"

Mr. Lucien Arbel's Patent Anti-Dust Ribbed Disk-Wheels.

(*Technical Journal of the Alumni of the National College of Art and Trade.*)

THE disk-wheels hitherto used, with projecting portions which are either straight or rounded, according to the form of axle, have the great disadvantage, in the case of fast trains, of accumulating considerable dust between the projecting portions and the outer face of the tire, which dust falls into the grease-boxes when the train stops, and heats the axles. Thus it is not unusual, in long runs, for the heated axles to be removed from the cars and others substituted; which always disturbs passengers, especially when the changes are made at night. To avoid this inconvenience and prevent the accidents which might occur, several railroad companies have tried the plan of fastening a thin sheet-iron plate upon the outer face of the wheel, securing the plate to the rim and hub with screw-bolts. But this plan was a total failure, for the plates being insecurely attached to the wheels, were shaken off by the action of centrifugal force and shocks, and, moreover, the continual vibration of the thin sheet-iron plates produced a disagreeable noise.

After long study Mr. Arbel has invented a form of wheel completely satisfying every requirement, the process of manufacture being very simple and well adapted to his plant, so that he can fill large orders promptly.

PROCESS OF MANUFACTURE.

The ribbed disk-wheel differs from the common spoke-wheel merely by the addition of a plate welded to the

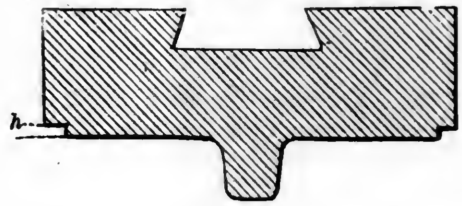


Fig. 1.

outer face of the latter. Hence, it is evident that the manufacture is divided into two distinct processes, which will be described.

The first operation is the forging of the common spoke-wheel, and the second, the welding of the plate to the aforesaid wheel.

First manufacture: Forging the common spoke-wheel.—The process of making a spoke-wheel being well known,

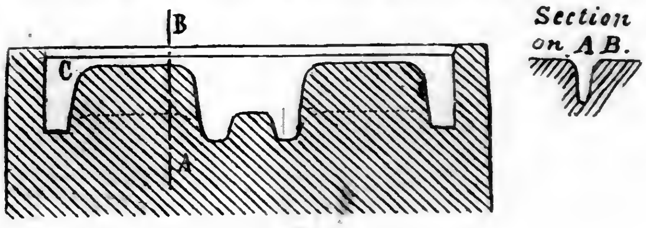


Fig. 2.

it is useless to detail the various steps; we will merely point out the differences between a common spoke wheel and the spoke-wheel which is to become a ribbed disk-wheel. These differences consist: first, in shaping the wheel, which is contained entirely in the lower die, Fig. 1, having simply a plane surface with a depression on the edge, of the depth h, about 1/8 inch less than the

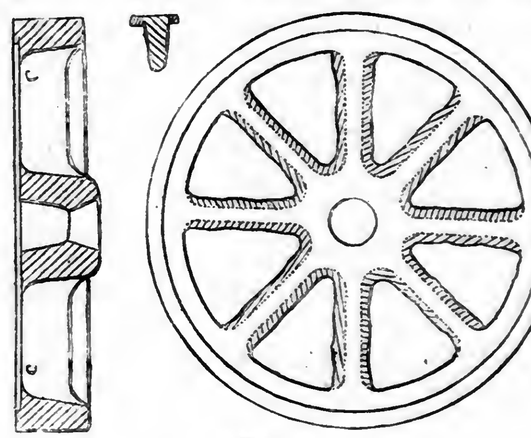


Fig. 3.

thickness of the plate; second, in cutting away the wheel, as shown by the hatched outlines, Fig. 3; finally, in finishing the seat for the plate in a lathe. Thus the sections of the rim, spokes and hub will have the form shown in Fig. 2. It will be noticed that all the sections are rounded on the edges so as to form, even on the projecting portions, depressions which will increase the surface of contact with the plate.

A second heating finishes this wheel, and gives it the form represented in Fig. 3. The wheel is readily cut out, as shown by the hatched outlines, Fig. 3, in a slotting-machine. The seat for the plate is quickly finished in an ordinary lathe.

Second operation: Welding the plate or disk to the spoke wheel.—This operation is very simple, and is performed as follows, the upper die being changed for a plane surface, Fig. 4:

First, the wheel is heated to a temperature of from 1,800° to 2,200° Fah., then the plate is placed upon the seat, Fig. 5, having been turned down to a diameter $\frac{1}{25}$ inch less than that of the seat, and having in the center a hole of less diameter than the bore of the hub. This

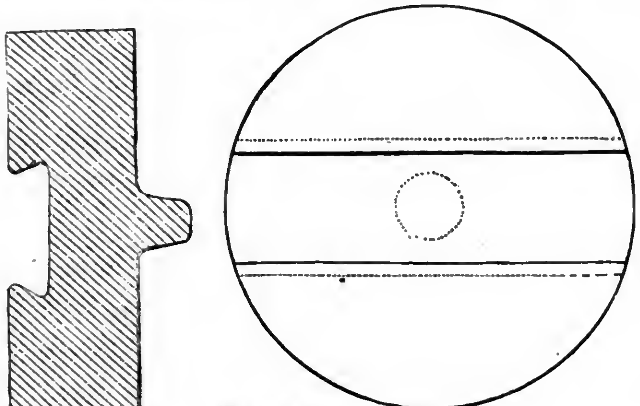


Fig. 4.

operation, which consists in heating the wheel before putting the plate in place, will be readily understood, by reason of the relative thickness of the plate in comparison with the thickness of the other parts of the wheel; consequently, all parts of the wheel simultaneously attain the required temperature. The plate being in position, the wheel is then put into the fire and brought to a welding heat, after which a few blows from a 20-ton ram are sufficient to weld all parts of the plate which are in contact with the wheel.

It is proper to state the projecting portions resulting from the first operation usually have a thickness of from $\frac{1}{8}$ to $\frac{1}{5}$ inch, and, as they are only cut away on the edges and not entirely removed in the lathe, the thickness of the wheel

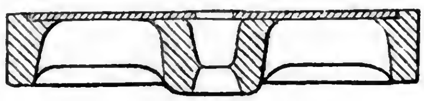


Fig. 5.

is also increased from $\frac{1}{8}$ to $\frac{1}{6}$ inch. This increase is intended as a provision for the losses of the second operation, and to act as a scarf and facilitate the welding of the plate to all parts of the wheel.

This wheel is readily adapted to all methods of connection with the tire. Figs. 6, 7, 8, of the accompanying cuts show the methods most generally employed. The last shows the standard adopted by several railway companies, among others by the Orleans Railway Company, also by the International Sleeping-Car Company. It gives absolute safety in case a tire breaks.

The wheel has the following advantages:

It does not raise dust, and presents no resistance to the air. It is, weight for weight, stronger than the disk-wheel with straight or rounded projections, and stronger, too, than the common spoke wheel, since the effects of

Fig. 6.

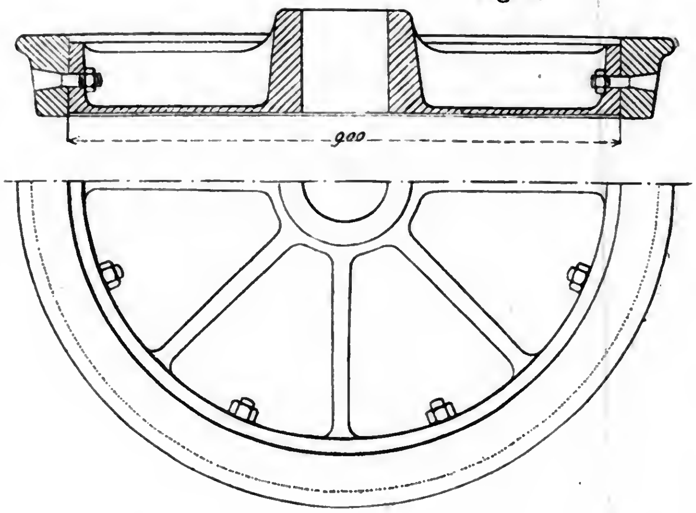


Fig. 7.

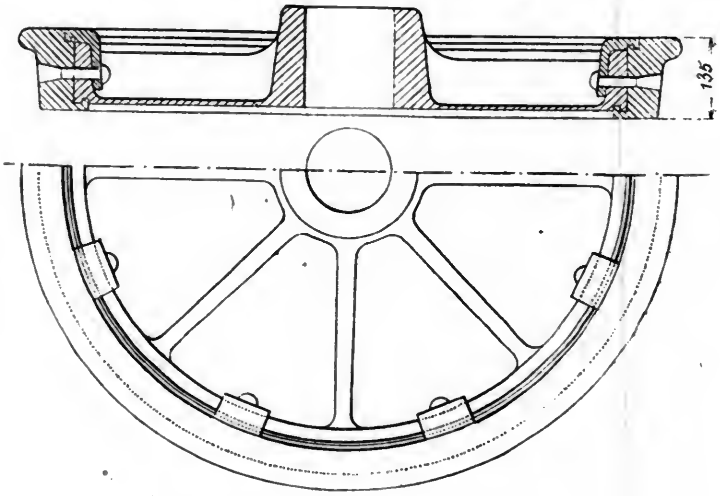
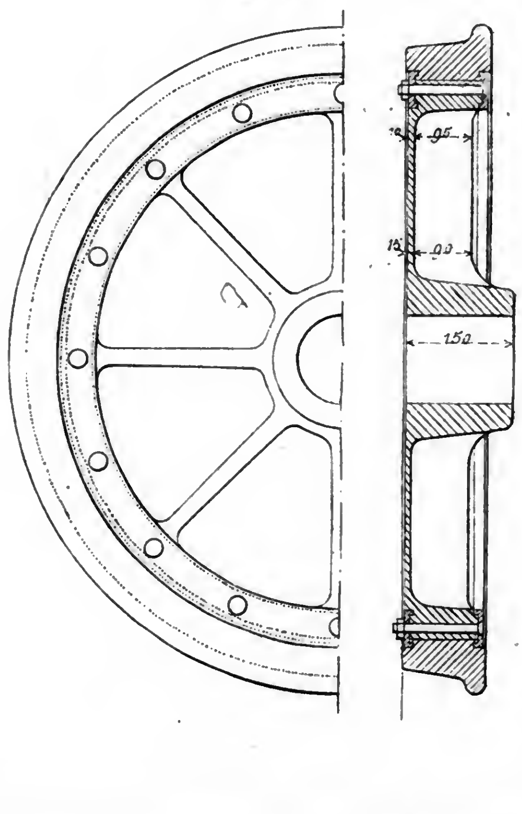


Fig. 8.



torsion and compression upon the spokes are greatly lessened by the resistance of the plate. It presents a much greater resistance and a much greater surface of contact to the strains produced by the tire. It is very easily kept clean. Finally, it is not liable to get out of shape in attaching the tire, as many experiments made by the Orleans Railway Company, in its shops at Paris, have proved; in brief, it has all the good qualities of disk and spoked-wheels, without any of the disadvantages of either.

The table annexed to the plate shows the result of experiments made by Mr. Chéret, Superintendent of the Orleans Railway Company. Tests made by the Eastern

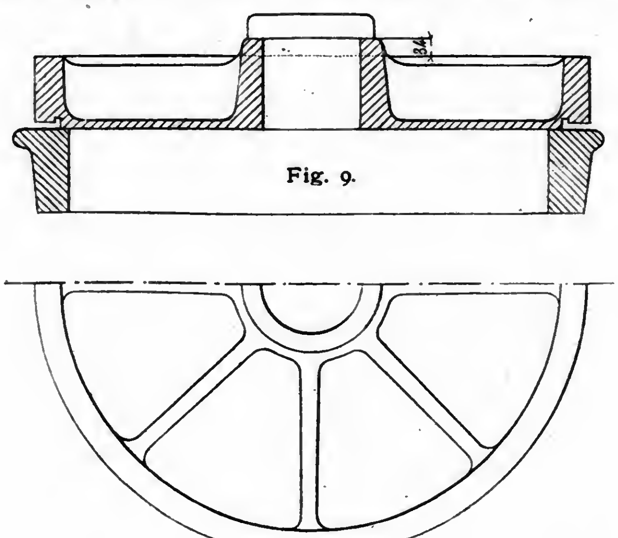


Fig. 9.

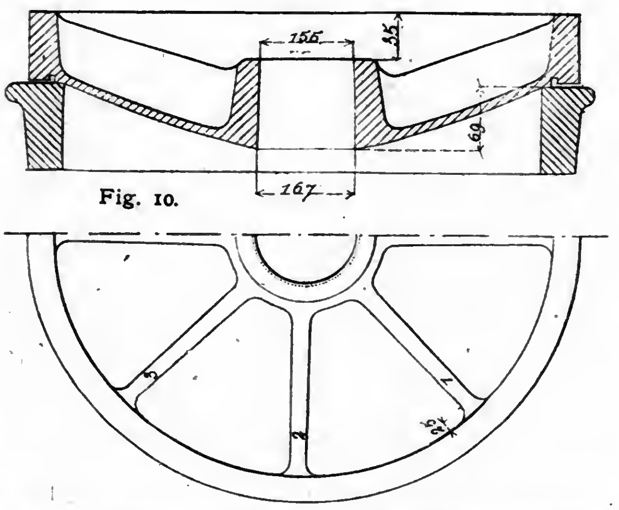


Fig. 10.

Railway Company and the International Sleeping-Car Company have given about the same results, and serve to confirm the qualities and superiority of this invention.

Comparing the results he obtained with this type of wheel, to the results obtained with spoked-wheels and common disk-wheels with straight or rounded projections, it is evident that the ribbed disk-wheel invented by Mr. Arbel is much superior to the wheels heretofore made; and, on account of the success achieved by the Arbel wheel, several railway companies have just determined to adopt it as the standard for all their passenger cars.

Now that the use of continuous brakes is very common, there is a demand for an article capable of thoroughly resisting heavy strains and having absolute rigidity. In these respects, the new wheel, it is claimed, has all the qualities which could be desired.

C. Chômienne.

Conzon, May 6th, 1885.

(In the cuts all dimensions are in millimeters.)

Methods of fastening the tire to the wheel.

Fig. 6, Eastern Railway. Fig. 7, Austrian-Hungarian State Railway. Fig. 8, Orleans Railway. Fig. 9, wheel before test. Fig. 10, wheel after test.

ARBEL'S PATENT RIBBED DISK-WHEEL.

The wheel was laid in a horizontal position upon a disk-shaped bed. A ram weighing 83,776 pounds, with a drop of 7.9 inches, striking upon a washer placed on the hub of the wheel, gave the results shown in the following table:

Number of blows.	Amount of bending, inches.	Remarks.
0	0	Ram resting upon washer.
5	0.24	
10	0.39	
20	0.71	
30	0.94	
40	1.10	
50	1.26	
60	1.34	
80	1.50	
100	1.62	
120	1.77	
130	1.85	
140	1.93	
150	2.01	Slight crack on spoke No. 1, about 1 inch from the interior of the rim.
160	2.72	

There was no breaking in the weld.

The increase of diameter in the bore of the hub, on the side where the plate was attached, was 0.47 inch, corresponding to an elongation of 7.7 *per cent.* without cracking.

Modern Warships.

Mr. W. H. White, Director of Naval Construction and Assistant-Controller of the British Navy, delivered in January at the Mansion-House, London, a lecture on "Modern Warships." The lecture, which was illustrated by diagrams and models, was one of a series given by members of the Company of Shipwrights.

Mr. White opened his lecture by explaining that his object was to place before the meeting facts and figures illustrating the progress of warship building in recent years, and that he should confine his attention almost exclusively to the period between 1859, when the iron-clad reconstruction of the Royal Navy began, and the present year. This period had witnessed greater changes than had taken place in the whole preceding history of warship building. When he entered the admiralty service 28 years ago the too long-deferred steam reconstruction of the Navy was in full swing, the Admiralty, forced on by the action of Napoleon III and his able naval architect, M. Dupuy de Lome, having at last faced the necessity of fitting screw propellers and steam machinery to the largest classes of warships. In the century and a-half perceding this change the progress made in shipbuilding was slow, and vessels remained effective for long periods, the *Victory*, for example, being 40 years old when she fought at Trafalgar. The lead taken by the French in the steam reconstructions and in the constructing of iron-clad fr gates such as the *Gloire* was undoubtedly the primary cause of most subsequent activity in warship building. English naval authorities in 1858-59 would, no doubt, have gladly postponed action in the building of armorclads had they been free to decide. The *Gloire* and her consorts made action imperative, and in May, 1859, the first English sea-going armored ship, the *Warrior*, was ordered. In France, the *Gloire* and nearly all her consorts were really converted Napoleons, in other words,

wood-hulled screw two-deckers, converted into armored frigates. The *Warrior*, on the other hand, was an entirely novel design, of unprecedented length and size, with iron hull and new structural arrangements and fittings. The *Gloire* and *Warrior* and all their successors owed their existence to the terribly destructive effects of shell-fire on unarmored wood-built ships. The primary use of armor-plating was to keep "common shell," with large bursting charges, out of the batteries of ships, and for a long period the struggle between the "attack" and the "defense" in warships was chiefly one between guns and armor. The 4½ inch armor and thick wood-backing on the *Warrior's* sides were practically proof against the heaviest shot, as well as the shell, of the armaments carried when she was designed. In the first stage of the contest, therefore, the defense scored victory, but it was not a lasting one. Gun manufacture rapidly developed and continued to advance, improved kinds of powder were devised, projectiles were produced of a vastly superior kind, and so, step by step, the power of this form of attack had been increased to an astounding extent. Shortly stated, guns had been increased in weight from 4¾ tons to 110 tons, in powder charge from 16 lbs. to 900 lbs., in weight of projectiles from 68 lbs. to 1,800 lbs., in "energy" (measuring the force of the blow struck on impact) from 450 foot-tons to more than 50,000 foot-tons at a range of 1,000 yards. The 68-pounder failed to penetrate the *Warrior* target, with 4½ inches of wrought-iron armor, at close range; the 110-ton gun could penetrate 35 inches of iron at 1,000 yards. There could be no question but that the power of the heaviest guns now carried in warships, as compared with the resistance of the strongest armored defense in existing ships, was greater than it had been at any time since the iron-clad reconstruction began. Nor was the end yet reached, for new projectiles and explosives were being produced which might reasonably be expected to place the attack in an even superior position in relation to the defense. From the very nature of the case, the attack must have greater flexibility and capability of variation of development than the defense. On the other hand, it was but right to note that the defense showed to least advantage under the conditions of peace experiment. These conditions were altogether favorable to the attack; and in actual warfare, as was well known, the gun did not show the same power as at Shoeburyness, Gavres or Spezia. Speaking broadly, from 1859 to 1873, the first half of the period under review, the most notable changes in warships might be said to have resulted from the desire, on the one hand, to carry fewer but heavier guns under armor protection, giving to these guns great horizontal command; and, on the other hand, to increase the defense by thickening armor over the protected portions of ships, obtaining this result by carrying larger relative weights of armor and diminishing the ratio of armored surface to the total surface of the ship's sides. After the old-fashioned broadside system of mounting guns, as in the *Warrior* and *Minotaur*, came the "belt and battery" system of 1863-67, exemplified by the *Bellerophon* and *Hercules*. The *Devastation*, of 1869, marked another step, the introduction of the "breastwork monitor" type, in which sail power was frankly abandoned and twin screws intrusted with the safety of the ship at sea. The *Inflexible*, of 1874, with her armament of four heavy guns in two turrets, with complete command of the horizon, represented in the highest degree the principle of concentration of armor and armament. At this period our clever neighbors across the Channel perceived that while our sailless turret ships of moderate freeboard, with very few but heavy guns, had great fighting power, they also had special weaknesses. So when they set to work on the new French fleet, after the war of 1870, they designed ships in which the few heavy guns were mounted *en barbette* high above water; and associated with these a large number of lighter guns, in positions not protected by armor. These light guns could be fought either simultaneously with the heavy guns or independently, worked and fired with great rapidity, and under many circumstances must clearly be of the greatest value both in action between battle-ships and in repelling torpedo attacks. The construction of these new foreign ships led to the design of the first barbette ships of the *Admiral* class in 1880, and to the laying down of five other similar vessels in 1880-82. In these ships each of the two barbettes was a seperate armored citadel, complete in itself and far distant from the other. In fact, the principle of "distribution" of the main armament, instead of concentration and the association therewith of a powerful secondary armament, was the key of the design. Coming to vessels designed still more recently, it was interesting to note that the *Trafalgar*, designed in 1885, which might be described as a greatly improved and strengthened *Dreadnought*, a vessel which was re-designed in 1872, was rather greater than the largest French ironclads, the *Amiral Baudin* and *Formidable*. The *Trafalgar* and her sister ship, the *Nile*, were surpassed only by the great Italian ships of 13,500 to 14,000 tons. Since displacement or total weight was the naval architect's stock-in-trade, it might be confidently anticipated that the increase in size and cost of our latest armor-clads, as compared with the vessels of 9,000 to 10,000 tons, laid down in the years 1875-84, would be accompanied by a corresponding gain in some feature of their fighting efficiency. Referring next to the debate proceeding as to the desirability or otherwise of a change from compound armor (steel-faced iron) to steel armor for future English ships, the lecturer declined to express an opinion on the subject, adding that France used both steel and compound; while Austria, Germany, Russia and Denmark used compound armor like that now fitted to English ships. Speaking of the enormously heavy armament of line-of-battle ships, he mentioned that in the *Italia* and *Lepanto* the total weight of the barbette, guns and mountings, carried at a height of about 30 feet above water, exceeded 2,000 tons—a load closely approaching the total weight of the first-class line-of-battle ship of the 18th century. There were not wanting advocates of the view that the risks of failure incidental to the mechanical appliances for loading and working our monster guns were too serious to be accepted, and that the guns had outgrown the necessities of the naval service. They pointed to the comparatively long time occupied in loading a very heavy gun, to the unavoidable uncertainty of naval gunnery, and to the enormous value of a single discharge, which might mean a "miss." They considered that a much greater number of lighter guns would be preferable. On the other side, it was urged that in active service so many circumstances made against the effectiveness of gun-fire, that a large margin of power was desirable; that a single successful shot or shell from the heavier guns would produce enormous damage; and that the association of a powerful secondary armament with the heavier guns fully met the case. Having stated both sides of the question he would leave it, only adding that in the latest ships, both English and foreign, while heavy guns were to be carried, they were not the heaviest available. There was a remarkable movement, now in its early stages, but undoubtedly destined to great development, in the construction of quick-firing guns, and mountings for them. A quick-firing gun was capable of delivering from eight to ten well-aimed shots per minute, or possibly more. Beginning with a 6-pounder, to which a 3-pounder was soon added, this class of gun had already reached a 40 pounder, and promised to embrace still larger calibers. Such rapidity of fire, combined with accuracy, range, penetrative power and shell-fire, would undoubtedly prove of enormous value, and could not fail to have an effect on both the armaments and the protection of ships. In some cases attempts had already been made to give protection against the 6-pounder, which could perforate 2¾ inch steel plates at 500 yards; this protection was, however, quite inadequate to resist the fire of the 40-pounder; and so there seemed to be a possibility that another chapter might be opened in the duel between guns and armor. Directing attention to the influence exerted upon modern war-ships by the introduction of the locomotive torpedo, he showed that it had not merely influenced the armaments, structures and equipments of all ships, but had led to the construction of a flotilla of swift vessels, fitted for its use, ranging from boats of 12 or 13 tons displacement and 15 knots speed up to the *Polyphemus* of 2,640

tons and 18 knots speed. The discovery of the *minimum* size of swift torpedo vessels or torpedo boat destroyers, really capable of independent sea service with a fleet, was now engaging attention in all navies. In France the first attempts were made in the *Bombe* class of 18 knots and 320 tons designed in 1883. Here the *Grasshopper* class were designed early in 1885, and the first completed vessel, the *Rattlesnake*, was now commencing her speed trials. These vessels were of 450 tons and estimated to steam about 19 knots an hour. Messrs. Thomson, of Clydebank, had just completed another example of the class intermediate in size between the *Bombe* and the *Grasshopper*, and said to have attained the very high speed of 22½ knots on trial in smooth water. Experience at sea with these vessels would be of immense value to future designs. Submarine attacks by means of diving boats, capable of being propelled at the surface or under water, had been much before the public of late, several such vessels having been built and tried. In the past very many experiments had been made with this class, and the conditions of the designs had been most carefully studied. To gain certain obvious advantages in these under-water attacks very considerable risks must be run; and in the actual operations with such vessels, difficulties of a very formidable nature would have to be overcome before anything approaching certainty in delivering an attack on an enemy could be insured. Everyone would watch with interest the further trials of the vessels with which experiments were now being made. After a reference to the great development during the last four or five years in the construction of swift "protected" cruisers, the lecturer directed attention to certain important matters common to all types of warships, and largely affecting their efficiency as well as their cost. A warship, he explained, was minutely subdivided into a very great number of water-tight compartments in order to gain increased safety against under-water attacks. It was not at all uncommon to find 80 to 100 separate compartments in the hold space of a large ship. All the internal space was appropriated to, and more or less elaborately fitted for, specific purposes. Except the coal bunkers there was practically no space without special fittings for particular portions of armament or equipment. There were no spaces corresponding to the cargo holds of merchant vessels, and frequently it was very difficult to find suitable and available space even for necessary stores, owing to the great demands for accommodation of guns, torpedoes, ammunition, etc. All these compartments had to be drained, ventilated and made accessible. Water-tight doors, sluice valves, drain pipes, suctions, ventilating trunks and fans, voice tubes, telegraphs, electrical circuits for gun and torpedo work as well as for internal lighting had to be provided for. Wherever a steam or exhaust pipe or any gearing passed through a water-tight bulkhead or platform the joint had to be made water-tight. Valves of all kinds, automatic and worked by gearing, had to be multiplied in order that the water-tight subdivision might really be maintained. In a large armored ship it was not uncommon to find more than 100 tons weight devoted to ventilation only, although the ventilation trunks were made of the thinnest sheet-iron or steel. In such a ship, excluding the steam pumps, as much as 80 to 90 tons weight might be absorbed in fitting up the drainage and pumping appliances with their necessary valves and gearing. To work in such weights of material was necessarily a cause of very great expense from which there was no escape, as the fittings could not be simplified with due regard to their efficiency and the preservation of the all-important subdivision. Another very noticeable feature in modern warships was the extended use of mechanical appliances as substitutes for manual labor. In this respect merchant ships doubtless led warships; but in recent years there had been a great and growing tendency to use steam and hydraulic power. In a first-class armored ship of the most modern type there were as many as 76 auxiliary steam and hydraulic engines. From the foregoing statements it would be obvious that the task of designing and building modern warships would be one of great difficulty, even if it were possible to fix beforehand all the conditions to be fulfilled in armament and equipment. Since the iron-clad reconstruction began, however, no such fixity in design, especially for the larger classes of ships, had been obtained. The progress in guns, torpedoes, equipment, materials of construction, propelling apparatus, etc., had been rapid and continuous; and there was a great desire to embody these improvements in vessels still incomplete at the date of their introduction. Of course these additions and alterations meant greater cost, and generally greater weight. In some ships where the construction had extended over six or seven years, changes had been made which, in the aggregate, involved additions of no less than 400 to 500 tons, as compared with the original design. The case of the *Inflexible* was taken as an example. Every naval architect would infinitely prefer to be able to complete the ships for which he was to be responsible in strict accordance with the first design; and in vessels of the smaller classes, occupying less than two years in completing for sea, this desire might be realized. But with the larger classes of warships, of which the construction spread over three or four years, even when money was fully available, the case was different. Improvements were made in armament or equipment, which could be introduced if some additional weight and cost were admitted. The gunnery officer wished to introduce some new type of gun or some heavier charge for a gun, and this addition involved weight and cost. The torpedo officer and the electrician saw their way to improvements also, and the marine engineer desired some greater latitude than was originally allowed, so that he might produce a substantial increase of power and a higher speed. Resistance to these appeals was possible, of course, but very difficult, and he was scarcely sanguine enough to anticipate that in the future there would be no recurrence of difficulties similar to those experienced in the past. Moreover, this matter did not stop with the first completion of a warship at sea. Changes, additions and re-armament were the rule during the whole period of her career For instance, in the building of the *Warrior*, about 200 tons weight of additions were accepted; and in the 14 years 1861-75 no less than 400 tons more weight were added to the hull, armament and equipment. From the first commission of the *Bellerophon* in 1867 to the last commission in 1886, when she received an entirely new armament of breech-loading guns, over 800 tons additional weight had gone into her. The *Invincible* class had also received on board large additions of weight, involving an increase in draught of water of more than a foot. Cases such as these might be multiplied in foreign as well as in English ships. Adverting to the question of speed, which, he said, was admitted to be of primary importance for all classes of ships, he showed how great had been the improvement in this respect in recent years. Fourteen knots an hour on the measured mile was almost a standard speed for large ships from 1859 to 1875. In the smaller classes of unarmored vessels speeds commonly ranged from eight to 13 knots; and the swiftest cruisers, designed to meet the American *Wampanoag* class, had speeds of 15 to 16½ knots. At the present time the Italian iron-clads of over 13,800 tons displacement had attained speeds of 18 knots per hour; and in the Royal Navy armored vessels of 8,000 to 10,000 tons had speeds of 16½ to 17 knots. Cruisers had speeds of 18 to 20 knots, and small torpedo craft of 19 to 25 knots. But still higher speeds were demanded, and would no doubt be attained. It was the fashion to deny the performances of warships, and to speak of their measured-mile trials as mere *tours de force*, never more to be repeated. To this he would reply that, as between all classes of warships, British or foreign, the measured-mile trial in smooth water was a perfectly fair and complete test of performance. It was confessedly not representative of ordinary practice. The best of coals and stoking were secured, calm weather was selected, the trials were not long continued and everything was in first-rate order. But all these precautions were necessary to secure that uniformity of practice which could alone make the trials absolutely fair and comparable between ship and ship. No one imagined that these measured-mile conditions would be reproduced on service, and the "sea speeds" of all warships were always estimated on

different assumptions. Experience had shown that about two-thirds of the *maximum* power realized with natural draught on the measured mile might be continuously developed under service conditions, and for as long a period as the coal would last; and it had been ascertained by actual trial that the average speed maintained in long-distance steaming in fair weather approximated fairly to that obtained on the smooth-water trials with two-thirds the *maximum* power. The difference between the *maximum* measured mile and *maximum* sea speed of warships of course varied in different classes of ships and for different *maximum* speeds. Roughly speaking, a knot to two knots would be an outside allowance off the measured-mile speed of most of the warships afloat. Familiarity with steamship performance was apt to blunt the perception of the really marvelous results attained. For his part he often felt with Agur—that "the way of a ship in the midst of the sea" was beyond full comprehension. When it was realized that a vessel weighing 10,000 tons could be propelled over a distance of nine knots in an hour by the combustion of less than one ton of coal—the ten thousandth part of her own weight—it must be admitted that that result was marvelous. Examining next the question of cost, he pointed out that the first cost of a 100-gun line-of-battle ship at the beginning of the century was about £65,000 to £70,000, armament and ordinance stores being excluded, while now the *Trafalgar* and *Nile*, designed in 1885, were estimated at £860,000 each. Adding the value of guns, ammunition and stores, it might be said that the captain of the *Trafalgar* had the responsibility of navigating and fighting a machine representing a million sterling. The estimated value of the largest French iron-clad was from £600,000 to £650,000, and of the Russian from £700,000 to £750,000. In the *Inflexible* the armor-plating alone cost £170,000, the propelling machinery £126,000, the hydraulic gun mountings and auxiliary engines of various kinds £55,000. These three items alone would have produced five first-rates of Nelson's time. The cost of the completed ship represents 12 first-rates of 1800, seven of 1840, and three and a-half of 1859. For the same sum of money there could now be produced four powerful protected cruisers, steaming 20 knots an hour—six knots faster than the *Inflexible*—and carrying guns capable of piercing 20 inches of wrought iron at 1,000 yards; or a fleet of 30 to 40 swift torpedo craft of various sizes, steaming 20 to 25 knots an hour. Who was to decide what was the best investment of a million sterling, when such different appropriations were possible? The growth of cost ran through the various classes of modern fleets. To obtain a sloop-of-war of modern type, carrying six or eight guns, costs little less than did the 100-gun three-decker of 1800. To build and equip a torpedo boat of the first class costs nearly as much as a sailing frigate of 50 guns in Nelson's time. Large as had been the sums annually spent on shipbuilding during the last quarter of a century, they had not been large enough in proportion to the number and cost of the new ships in hand to permit of rapid construction. This financial limitation, or want of funds in relation to work incomplete, had sadly hampered and hindered progress and completion. Lengthening out the time over which a ship had been on hand, it had indirectly added to the cost, and had given time for the numerous alterations and additions to which he had referred. The Royal Navy was now very strong in armored ships, as was testified in no measured terms by the recent French official reports, and in the financial year about to begin this portion of the fleet available for service would be immensely strengthened by the completion of a large number of new swift ships.

But foreign navies without exception were making strenuous efforts to strengthen the classes of swift protected cruisers and torpedo craft, and, with our world-wide Empire and enormous commercial and shipping interests, this movement abroad compelled action here. For many reasons this development of the swift cruiser classes was to be welcomed. Such vessels were admirably adapted to the characteristics of the British sailor, and would give scope for fresh displays of that mingled audacity and skill which had become a tradition in the service since the time when the small but swift-sailing, handy vessels of the English fleet made havoc with the huge but unwieldy vessels of the Spanish Armada. (Cheers.) With reference to the possible use of mercantile auxiliaries in time of war, he said that he heartily sympathized with all that had been done in the last ten years to encourage methods of construction and subdivision which would better fit these vessels to receive an armament of guns and to be capable of fighting. He believed that in many ways these armed vessels would be of immense value to the country in time of war; but he did not concur in the opinion that they could be treated as substitutes for regular warships, and that the Navy could be reduced in numbers because these auxiliaries might be available, for there were radical and unavoidable differences in structure, protection, machinery and steering gear, as well as handiness and capability of using their armaments, between such vessels and regular-built fighting ships. Merchant ships, in point of handiness, did not and need not approach warships; but for fighting purposes handiness was a quality scarcely less essential than speed. In this connection, he might be allowed to point out how great were the demands made upon the intelligence, skill and courage of the officers and men who had to navigate and fight the warships of these days. How great was the difference between the acquirements necessary for naval officers of the present time and those which sufficed in Nelson's time! Every additional appliance and precaution introduced by the designer, every auxiliary machine, every new weapon added to the responsibility of those who had to care for and use them. Modern naval officers required an acquaintance with scientific and practical gunnery, hydraulic machinery, electric apparatus and torpedo management in addition to the mastery of their primary duties as sailors. Of course there was a necessity for specialization in this knowledge; no one man could be expected to have an exhaustive knowledge of every branch. The gunnery officer was a specialist for guns and gun mountings; the torpedo officer for torpedoes and electric appliances; the engineer officer for machinery of all kinds, and all the multifarious mechanical appliances fitted in a modern ship. Working together under a common head, these officers had never failed, and would never fail, to perform successfully their onerous and increasingly difficult duties. Nor had they, while adding to the range of their knowledge and professional culture, lost the resource, dash and daring for which the service had always been famed. On all occasions, and under the most varied circumstances, they had proved in recent years that this was the simple truth. Every one there would have in mind the never-to-be-forgotten story of the rescue of Sir Charles Wilson and his comrades by the gallant chairman and his sailors, who proved themselves equally at home on the march and in the battles of the desert as they did when running the gauntlet of the batteries on the Nile or "mending the boiler" under fire. (Cheers.) In conclusion, he desired to say that he had purposely avoided anything of a controversial nature, and refrained from attempts to assign individual credit for the many and great improvements which had marked the iron-clad period. His wish had been to indicate in general terms the character and scope of recent changes, and to illustrate the difficulties that had been overcome as well as the results attained.

The Thornycroft Torpedo Boats.

(From *The London Times.*)

LAST week No. 60 first-class torpedo boat arrived at Portsmouth from Chiswick, and, as this vessel is the last of the 25 which Messrs. Thornycroft have had in hand for the Admiralty, it may not be out of place to give a short description of these vessels and of the results which were obtained from them on their official trials. The vessels in question form a moiety of 50 boats ordered by their Lordships, 20 out of the remaining 25 being ordered from Messrs. Yarrow & Co., and five from Messrs. White, of Cowes. The dimensions of the Thornycroft boats are: length over all, 127 ft. 6 in.; beam 12 ft. 6 in.; draught of water with the specified load of 11.56 tons on board, 1 ft. 9 in. forward and 6 ft. aft; stipulated speed on measured

mile, 19 knots. The design was the outcome of the joint labors of a committee of naval officers and the builders, the much-abused snout, of which, with its attendant cascade, so much has been heard, being adopted partly to reduce the weight forward, and partly to secure the breakwater advantages which were found so valuable on a similar vessel, the *Childers*, on her voyage to Australia.

With a view to securing great manœuvering power the system of double rudders patented by Mr. Thornycroft was introduced. These rudders are placed one on either side of the propeller and are curved to a radius a little larger than that of the propeller, so that the propeller practically works in a tube with the bottom half cut away, the result being that when the rudders are put over the whole of the stream from the propeller is diverted sideways; and as there is no dead wood to resist side motion the vessel is turned with great rapidity, and this whether the vessel is going ahead or astern. Curiously enough, in some instances the time of turning the circle is less when going astern than when going ahead. The hull, which is built of Siemens-Martin steel, is divided into a large number of compartments by means of bulkheads and half-bulkheads, so that if the skin should be perforated the quantity of water entering at any one place is limited to the volume of the injured compartment, and these volumes are kept sufficiently small not only to prevent the boat sinking, but to allow of her being navigated while in this disabled condition. Steam ejectors are provided, so that if the hole is small or temporarily stopped the compartment may be rapidly cleared of water and the vessel restored to her former efficiency. The accommodation for the crew, as is usual in torpedo boats, is forward in the torpedo room, and that for the officers is aft, the intermediate space being occupied by the machinery. Steam stearing gear capable of being used by hand is fitted in all the boats, so that not only are the rudders put over with great rapidity, but, as very little manual labor is required, the steersman is enabled to devote the whole of his attention to the actual navigation of the vessel. The machinery is of the type used in torpedo boats, and consists of a pair of compound engines, capable of developing from 700 to 750 indicated horse power, and a locomotive boiler. All the pumps, with the exception of the circulating pump, are worked off the main engines, an arrangement which reduces very considerably the work of the engineers in looking after the engines.

The first five of these vessels were intended to be armed as torpedo vessels, but the remaining 20 were to be armed with quick-firing machine guns and to be used as torpedo boat destroyers. This intention, however, was so far modified that all the vessels were fitted with torpedo gear as the normal armament, but arrangements were made so that, if desired, the torpedo tubes could be removed and the quick-firing guns substituted. Stated briefly, a torpedo tube is simply a gun for ejecting locomotive torpedoes, the ejecting medium hitherto being usually compressed air, but now, and in the case of the boats under notice, gunpowder. The *modus operandi* of loading one of these tubes and discharging the torpedo is as follows:—First, the torpedo, with its "business end" duly filled with gun cotton and its air reservoir charged with compressed air, is placed in the tube with the end of the horizontal rudder frame pressing against the retaining catch; then the small silken bag containing pebble powder is placed in a pocket inside the door of the tube and the door closed and secured. A second cartridge, brass-cased, containing finer powder and capable of being discharged by electricity, is then inserted in a piece of mechanism on the outside of the door, which serves the double purpose of retaining the brass cartridge while being fired and of serving as an ejector subsequently. A heavy weight on the end of a lever at the side of the tube is then raised and retained in the raised position by means of a catch which may be released by an electro-magnet, and a forked appliance, to which the wires from the battery are attached, is inserted in the firing cartridge. The tube is now ready for firing, and all that is necessary to discharge the torpedo is to press a button so as to make contact between the two wires. The first result of this operation is to release the catch holding the weight, which, falling, pulls back the retaining catch, then makes contact with the wires leading to the firing cartridge and so explodes the powder. The torpedo is then blown out of the tube, the air valve in the torpedo being opened as it passes along the tube by means of a tripper in the top of the tube. The noise of the discharge is no louder than would be made by clapping the hands sharply together with the palms a little hollow. Each of the boats under notice is fitted with five of these tubes, one being fixed in the bow and four revolving in pairs round each of the two conning towers. Each pair of revolving tubes is so arranged that when making a passage the tubes may be stowed on stands parallel to the center line of the vessel. When cleared for action they are fixed so as to have an angle of 40 deg. between them, and in this condition may be revolved freely round the conning towers. If, then, the tubes on the forward tower were fixed with the after one abeam, and those on the after tower with the center line between the two tubes abeam, it would be possible to fire one torpedo ahead, one 40 deg. before the beam, one 20 deg. before the beam, one abeam and one 20 deg. abaft the beam. The whole of the five torpedoes could thus be discharged at an enemy's vessel one after the other, the torpedo boat making a curve and discharging each tube as it came to bear on the enemy. Or, if running between two ships of the enemy, she could divide her favors by fixing the tubes so as to bear on either beam. In addition to the torpedo armament, each vessel was fitted for carrying three Nordenfelt guns and a powerful electric search light. The first vessel, No. 25, was ordered as a trial vessel and was fitted out complete by the contractors, the torpedo gear for the other vessels not being ordered till that on her had been subjected to an exhaustive trial. With a view to expediting delivery, the orders for the torpedo gear of the remaining vessels were divided, Messrs. Thornycroft supplying ten sets in addition to the first, Messrs. Maudslay, Sons & Field ten sets and Messrs. Penn four sets.

The speed trials were conducted partly on the Thames at the measured mile in the Lower Hope, partly at Stokes Bay, and although, owing to structural additions and other causes, a much greater load was carried than was specified in the contract, in some cases over 16 tons being carried instead of the specified load of 11.56 tons, the speed was always considerably above the contract speed, in one case 21.66 knots being obtained with a load of nearly 14 tons on board. The average speed of the whole of the 25 boats on the measured mile was 20.39 knots, or 1.39 knots above the contract speed. As might have been expected, the results of the circle trials were also satisfactory, the average time of turning being 85 sec. when going ahead and 87 sec. when going astern. Further improvements, however, may be expected in this direction in subsequent boats, as, owing to the heavy deck load, it was not considered advisable to use the full power of the steering apparatus.

A Locomotive Floating Dock.

(By a Correspondent of *The London Times*.)

NEARLY sixteen years ago the late Lord Hampton, then Sir John Packington, said, "Nobody could contribute a more valuable addition to naval contrivances than to invent a really efficient floating dock, and not only a floating dock, but a dock which when afloat may go to any part of the world." This idea lay dormant for a long time, but has within the last year or so been revived, seriously considered, and is now in a fair way of being carried into effect. Messrs. Rennie, the well-known marine engineers, have devised a navigable floating dock, on an entirely new principle, the designs for which have been most favorably received by the Admiralty. The swift cruisers that naval men are so continuously crying out for would soon cease to be swift if some means for frequently cleaning their copperless bottoms were not provided, and no contrivance appears likely to be so efficacious for this purpose as a dock which could be at the

disposal of a fleet, or division of a fleet, on almost any given part of a station, supposing always that the dock is capable of rendering the services expected of it. Everybody knows that all docks, whether fixed or floating, require considerable pumping power as a matter of course. The one striking original feature in Rennie's design is that this very pumping power is used to propel the dock from place to place when a change of quarters is necessary, and also to careen the dock for purposes of examination, cleansing or repairs. The method of propulsion to be employed is the hydraulic arrangement which, *pace* Sir George Elliot, was not a brilliant success in the *Waterwitch*, but which will be quite sufficient to give the locomotive dock a speed of about six knots, while the advantage of making one set of machinery do the work both of propelling and pumping is obvious. The plans and estimates that have been got out are, in the first instance, for a dock capable of taking in a ship of the *Arethusa* or *Phæton* type, say 300 ft. long, 46 ft. beam, 20 ft. draught and 4,000 tons displacement. Such a dock will have to be 350 ft. long, 96 ft. outside and 60 ft. inside width with a total height of 35 ft., and would be available for use in any harbor of six fathoms depth. Its cost is put down for hull (steel), machinery, capstans, cranes, etc., as £105,000. This does not include anchors and chain cables, as these are always supplied by the Admiralty. The time required for construction would not exceed twelve months. A word as to the careening of the dock. This is effected by utilizing the pumping machinery for filling the water-ballast chambers on either side. The engines would then be stopped and all made secure for careening, when the sluice valves on the side to be raised out of water would be opened, and the dock would gradually heel over so as to expose the under-water part up to the keel. When one side is done the same operation can be performed for the other side. Of course it goes without saying that all the necessary calculations as to stability, strength of materials and horse-power have been most carefully made. It would certainly seem, should this dock fulfil the expectations of those competent to judge, that a great want is in a fair way of being supplied, and it is to be hoped no time will be lost in making the experiment. Such a dock would be most suitably and conveniently berthed at a coaling station, whence at need it could proceed wherever there was sufficient water and shelter.

A New Steamer for the Australian "Orient" Line.

A NEW steamer, the *Ormuz*, has just been completed, and is described as follows in the *London Times:* "She is the latest addition to the Orient Line and the largest vessel that has ever entered the port of London. One naturally examines the arrangements of the *Ormuz* under the branch of safety in relation to the catastrophe which befell the *Oregon*. The *Ormuz* has ten compartments which can be made water-tight by the closing of iron doors, and it will be remembered that the *Oregon* could have been steamed into shallow water and perhaps saved if those on board had succeeded in closing a single door between the furnaces and the injured coal bunker. Every one of the doors on the *Ormuz* can be closed by powerful screws worked from the main deck, and at the spot where they are worked is an index showing exactly in what position the door is. Not only so, but in the case of the doors in the neighborhood of the engine-room, where instantaneous action may be necessary, the removal of a small iron peg is all that is needed to permit the door to fall of its own weight. The door being sharpened at the bottom it will sever any obstacle, such as coal, that may be in its way, and it is not probable that anything less easily cut will be there. The means by which the doors are closed from the main deck consists of a worm-wheel on the end of a rod working on a rack the whole length of the door. This worm-wheel is pressed into the teeth of the rack by a bar which is held across the top of the doorway by a staple and pin. As soon as the pin is removed the bar ceases to press the worm-wheel into the rack, and the door falls with irresistible force. This is the plan adopted in the case of all the doors connected with the engine and boiler compartments. In cases where it is necessary the door should slide from left to right the closing is done on the main deck only. Passengers on the *Ormuz* will be able themselves to see where these doors can be closed. In each case the apparatus is covered by a brass disc, about the size of a dinner-plate let into the floor, as, for instance, one of them is to be seen on the entrance to the drawing-room. Side by side with these are other screw rods for closing the ventilators and so prevent them from becoming aqueducts in case of a compartment being filled. It is impossible to say what combination of circumstances may arise to render these arrangements abortive, but nothing has yet been imagined that is not provided for in this respect. Similarly, on the decks above the water-line, iron doors are provided to isolate fire if it should break out.

In the course of her trials she made nearly 18 knots on the measured mile, but her passage round to London was much interrupted by fog, and the trip affords no sound criterion as to her speed. Her engines are the largest triple-expansion yet made, the diameters of the cylinders being 46 in., 73 in. and 112 in., respectively. With an indicated horse-power of upwards of 8,000, the propeller at full speed made 70 revolutions. The pitch of the screw is 29 ft. for each revolution—that is to say, if the screw-worm were bored into a deal board it would travel 29 ft. with each revolution, and in one minute of 70 revolutions it should progress 2,030 ft., or nearly two-fifths of a mile. This a properly set screw propeller actually does with a discount of from 6 to 12 per cent. only consequent upon the failure of the water to maintain an absolutely solid resistance. The vessel is 465 ft. long, 37 ft. deep and 52 ft. across at the broadest point. It is, however, impossible from casual inspection to state where that broadest point is, because the lines of the vessel are exceptionally fine and there is not a place upon her side that can be said to be flat. Her buoyancy and steadiness will be a matter of extreme satisfaction to the diffident traveler."

The Hooghly Cantilever Bridge.

THE *Indian Engineer*, published in Calcutta, gives the following interesting description of the railroad bridge lately completed over the Hooghly River, a stream that has for many years remained unbridged owing to the many obstacles to be overcome. This bridge was constructed from the designs of Mr. Bradford Leslie, Agent and Engineer-in-Chief of the East Indian Railway.

"The bridge, which is 1,200 feet in length, consists of three bowstring girders of mild steel and is constructed to carry a double line of railway 5 feet 6 inches gauge, the distance of main girders from center to center being 30 feet 8 inches.

"The central girder, which is 360 feet long and 52 feet high at the center, rests upon two piers 120 feet 6 inches centers thus forming a double cantilever, upon the extremities of which the ends of the two shore spans rest solid.

"The piers consist of masonry built inside steel caissons 66 feet long and 25 feet wide, with semi-circular ends, which were sunk to a distance of 100 feet below mean sea level or 120 feet below high water.

"The caissons which were built in 27 rings, 4 feet deep, were sunk to a depth of 108 feet, at which level an excellent foundation of hard yellow clay was obtained, but as the top of the caissons were then below high-water mark the pier was carried up a further 16 feet in solid masonry. Upon this were placed the steel standards, measuring 55 feet by 20 feet, upon which the girder is supported.

"The clear headway from the underside of the bottom boom to high-water mark is 33½ feet, and the height of rail level above mean sea level is 58½ feet.

"The approximate weight of the cantilever is 1,500 tons, and it is constructed with 12 bays of 30 feet each. The bottom boom, which is of box section, is composed of two web plates 3 feet 6 inches deep, the inner being ¾ inch thick throughout, while the outer varies, the maximum thickness being 1 inch. The bottom plates are 4 feet 8 inches wide and of varying thickness from ½ inch

to 1 inch, and the inner and outer strips range from 13 inches by ¼ inch to 27 inches by 1 inch thick. The angle irons are 6×6×¾ to 1 inch thick. The top boom is of similar dimensions, with the exception that the top plate attains a maximum thickness of 1$\frac{1}{16}$ inch.

"The ties and struts are formed with angle-irons and plates, the former being mainly composed of plates with strong cover-plates at the joints, while the latter are of lattice construction and by an ingenious disposition of material are rendered of great strength. In section they are square, having double angle-irons back to back at each corner; on two sides web plates are riveted between the two angle-irons, and on the other two sides the plates are riveted to their backs, the whole being stiffened by angle and flat-iron diagonal bracing.

"At a height of 18 feet above rail level the cross bracing commences, which is carried up to the top boom of the girder, the upper and lower members being connected by diagonal bracing. The cross bracing, which is 2 feet 6 inches deep, consists of web plates having outside longitudinal angle-irons and an internal bracing of angle-irons bent to form a rectangular section. The diagonal bracing between the upper and lower cross bracing is formed of channel-iron bars.

"Where the cantilever rests upon the piers, additional raking side struts have been put in extending to a height of nearly 40 feet. These struts are of similar construction to those first described, and measure 4 feet 6 inches by 3 feet 3 inches in cross section, the angle-irons being 6×6×¾ and the bracing 4×4×½ inch.

"The roadway is carried upon cross-girders 30 feet apart and 3 feet 6 inches deep, between which run the four girders carrying the rails. The flooring consists of $\frac{5}{16}$ inch steel plates secured to Z irons.

"The cantilever has been built with a camber of 6 inches from the piers to the ends, the portion between the piers being level. At each end of the cantilever a seating has been prepared for the ends of the shore spans to rest upon, and the latter have a bearing of 2 feet 6 inches in length. These girders are 420 feet long each and of similar construction to the cantilever, though, of course, of somewhat lighter section.

"The depth of the girder and dimensions of the top and bottom booms are identical with those of the cantilever, and the thickness of the plates and angles is as follows. In the top booms the web plates are 3 feet 6 inches deep, varying in thickness from ½ inch to $\frac{13}{16}$ inch. The angle-irons are 6×6×¾, and the thickness of the top plate, which is 4 feet 8 inches wide, varies from ⅜ inch at the ends to $\frac{13}{16}$ inch at the center. It is strengthened by inner and outer strips 13 inches and 1 foot 7½ inches wide respectively, whose thickness at the center is ½ inch each. Tee-irons are riveted to the outside web-plates to impart additional strength.

"The bottom boom is of similar section, but the tee-iron runner is left out, and the bottom plate measures 1 inch thick at the center; the inner and outer strips, which are both of the same width as those in the bottom boom of the cantilever (13 inches), are each ¾ inch thick.

"The struts are formed of 6-inch angle-iron verticals with 3-inch bracing. The ties are formed of flat bars as in the cantilever, and a channel bar riveted to both ties and struts traverses the whole length of the girder.

"The cross-bracing and wind-ties in the shore girders are much simpler than in the case of the cantilever, and, instead of commencing at a uniform height of 18 feet above rail level, are simply placed between the top booms of the two main girders. The weight of the shore spans is slightly above 1,000 tons each. At the river ends of the girders, a bearing is provided to rest upon those previously mentioned at the ends of the cantilever, and the junction is strengthened by plates riveted to both girders. At the shore ends pendulum bearings are provided, consisting of massive castings 13 feet high and 10 feet by 6 feet on base. These castings are A shaped, and near the top—which is bossed out to receive it—passes a steel pin some 15 inches in diameter, extending a few inches beyond each side of the casting, which is here two feet across. On these overhanging ends are keyed two steel links, 10 feet long by 2 feet wide, bored at their lower extremities to receive another similar pin which, in its turn, protrudes beyond the links and receives the weight of the girder by means of cast plates, bolted on either side of the latter, which are turned to a bearing and accurately fit upon the steel pin. As the links are free to move in either direction, any expansion or contraction is at once taken up.

"The abutments upon which the shore spans rest are of brickwork, and on the Hooghly side have been carried down to the yellow clay upon which the central piers rest; while on the Naihati side the clay was not reached, and the abutments rest upon a bed of gray sand.

"On the Hooghly side a brick viaduct, 2,000 feet long, was found necessary on account of the numerous buildings that would be interfered with by an embankment. The span of the arches in the viaduct is 30 feet, and instead of being turned upon wooden centers in the ordinary manner, wrought-iron trusses were made to the curve of the arch and rapidly put into place by means of a portable crane traveling upon a line of rails laid across the arch. These centers, on account of their portability, were found of great advantage, and the rapidity with which this portion of the work was constructed is no doubt due to their use.

"The Naihati viaduct is but 425 feet long and the arches of small span. Both of these viaducts were subjected to immense stresses during the time the shore spans were being built up and launched, and it was considered necessary to strut the arches and brick up a larger opening, over which a bridge is now in course of construction. It is satisfactory to learn that the viaducts showed no signs of weakness during the process of girder-building, and no settlement has taken place.

"As we have indicated, the shore spans were built up upon the viaducts from iron work prepared in England, fitted together and marked before sending out. The cantilever was built in the position it now occupies, a substantial staging being erected between the two piers. The length beyond the piers was simply extended as it was built up, and the advantage that this method possesses over that of building up on shore and floating out to site is too obvious to call for further notice."

Desiccated Sewage.

THE following description of a process of solidifying sewage is taken from the *London Times*: "The works are situated close to the Walthamstow sewage works and farm, and consist of a timber building, two stories high. On the ground floor is the driving power, consisting of a 12-horse engine and boiler; part of the desiccating apparatus is also on this floor, but the treatment of the sewage sludge commences on the upper floor. Here is a tank into which the sewage sludge is pumped after it has been chemically treated and deprived of its supernatant water by Mr. Jerram's arrangements in the adjacent sewage works. The tank will contain about 400 gallons of sludge, which is fed into the water-extracting machine through a 6-inch pipe, and the supply is regulated by a sluice valve.

"The machine, which is about 24 feet in length and 8 feet in width, consists first of a large sludge-vat, in which are two hollow, perforated, metal cylinders, 12 inches diameter, and covered with fine wire gauze having 6,400 meshes per square inch. These cylinders revolve against brushes, which keep the meshes of the wire gauze clear. By means of a pump a partial vacuum is created in these cylinders, and the result is that about 60 per cent. of the moisture contained in the sludge is extracted at this point. From this tank the sludge is delivered by a sluice valve on to an endless traveling web of wire gauze of the same mesh as that on the cylinders, the web being as wide as the machine—namely, 8 feet. This web is supported by brass rollers placed at intervals, and passes under two rollers and over two of Körting's exhausters, which remove

another 10 per cent. of the moisture. The sludge has now assumed the consistency of a thick paste, and in this condition it is passed between five pairs of rollers furnished with iron scrapers. From the last pair of rollers the semi-dried sludge falls into a hopper, whence it is fed into a disintegrating cage on the lower floor, and in which it is finally disintegrated and dried by a blast of warm air, leaving only about 5 per cent. of moisture in it. The solid particles of the sewage now assume the form of a coarse powder, which falls through the wire meshes of the disintegrator on to the head of an Archimedean screw running in a long trough, and by which means the powdered manure is delivered into a pit, whence it is packed in bags for the market. The continuity and efficiency of Mr. Astrop's system were satisfactorily demonstrated to those present, and it was stated that the resulting powder possesses a high manurial value. The process is certainly simple and effective, and if the commercial results of the use of the manure prove successful—and there appears to be no reason why they should not—the process would seem to offer a satisfactory solution of the sewage question under certain conditions."

The New York Boundary Survey.

THE report of the Regent's Boundary Commission upon the New York and Pennsylvania boundary not only announces the conclusion of an important work, but presents a complete account of it, and of the history leading up to it, from the time of the earliest royal grants. Of the octavo volume of 490 pages containing it, some 460 pages are occupied with the final report of the surveyor, Major H. Wadsworth Clarke, of Syracuse, and its interesting appendices.

It was in 1786 and 1787 that the Commissioners of the two States ran the line, as accurately as it could then be done, along the 42d parallel from the Delaware River to Lake Erie. A preliminary reconnoissance having shown that this line never did perfectly coincide with the parallel named, but certainly varied from it, sometimes to the extent of a thousand feet, and, moreover, that a large number of the old monuments were missing, so that the exact recovery of the old line at all points would be very difficult if not impracticable, the question arose, whether it would not be better to resurvey with the best modern skill and instruments of precision the parallel of latitude originally intended to be the boundary, and to establish as a boundary in future, without regard to the remaining monuments of a hundred years ago, the geodetic line thus determined. The Pennsylvania Commissioners at first favored the idea of a new line, but fortunately better counsels prevailed; the views of the New York Commission were adopted, and the important considerations of long-established usage and cadastral boundaries were not sacrificed to the fanciful advantage of astronomical accuracy. The Joint Commission set itself to work to recover the old line, from the Delaware to the corner with the western meridian boundary—a distance of 226.84 miles. The number of milestones on the old line was 224, the average distance between them being about 1 per cent. over a mile. Of these 224 milestones, 122 were found in place and undisputed; 37 were found removed from their places and in various stages of dilapidation; and the other 65 were entirely missing. Of other monuments known to have been on the line, 11 were found in place, though some of them were broken; 6 were out of place or missing—and doubtless others might be included in this last category, only that the memory as well as the material of them has disappeared. It was evidently high time to restore landmarks.

Mr. C. M. Gere, the surveyor on the part of Pennsylvania, having retired from active field work on account of ill-health, a high compliment was paid to Major Clarke by the request of the Pennsylvania Commissioners that he would act for both States; and the latter half of the work was conducted by him. To him, also, we owe the present exhaustive and valuable report, which, although dated in December, 1885, and transmitted to the Senate with the report of the Commissioners, April 22, 1886, has but recently been published as Senate Document No. 71, of 1886.

In addition to the work on the parallel boundary, the meridian boundary on the west (about 18⅝ miles in length) was restored, 51 monuments being set upon it. Of all this work, Major Clarke gives a complete, clear and interesting account, tracing, moreover, the history of all negotiations, transactions and surveys affecting either boundary. In the appendix are numerous curious data and documents, among which we notice a careful *résumé* of the boundaries given to New York and Pennsylvania on ancient maps, interesting accounts of the "Massachusetts claim," the "Connecticut claim in Pennsylvania," the "Connecticut Gore in New York" and the "Erie Triangle," and finally complete maps of the restored boundary showing locations of new monuments throughout. We do not hesitate to say that Major Clarke, who has skillfully restored and set so many monuments, has, in this final report, added a crowning one to the list—a monument to his own fame. He deserves to be, and we trust he will be, as long remembered as Mason and Dixon.—*Engineering and Mining Journal.*

Reorganizing the Signal Service.

Science, in a recent number, says: "The death of General Hazen, Chief Signal Officer of the Army, marks the close of the second period of the development of our weather bureau. During the ten years from 1870 to 1880, while the bureau was under the direction of its first Chief, General Myer, the labor expended upon it was given in greatest part to its organization. Stations had to be selected and their instrumental outfit determined; the time and kind of observations had to be decided upon, and observers instructed in their duties; the methods of reduction of data to practical form for use on a weather-map had to be adapted to the needs of a larger area than was ever before brought under the control of a single weather office. Apart from the almost exclusively military constitution of the service during these years, its most marked characteristics in contrast with the European weather services were the large sums of public money devoted to its support, the system of tri-daily observations, and the absolute control exercised over all telegraphic lines in the collection of reports, in virtue of the law of 1866. Its maps were thus prepared more frequently and more promptly than weather maps are abroad, and were admired all over the world.

"General Hazen took charge of a highly developed service, and turned his efforts in two directions that to most persons appeared quite contradictory. He insisted on the need of military organization, and, at the same time, introduced numerous and important improvements that had nothing military about them. But during his administration, public discussion was frequently turned to the advisability of 'civilizing' the weather bureau, for its work was not as successful as was desired. A committee of the National Academy of Sciences reported in favor of the change, the then Secretary of War urged it, and a joint congressional commission recommended it, three members of the commission advising a gradual, and three an immediate, transfer from military to civil authority. Popular opinion very generally supported these recommendations, and the chief objections to them came from the military element of the service itself. All the official declarations of the service maintained to the last that a military organization was essential to success in weather prediction. It might be forcibly contended, on the basis of published statements in the annual reports, that the service had, for its first object, the availability of its entire force in case of war, were it not that its whole public work refuted this theory. The real work of the service is the announcement of the approach and force of storms throughout the United States for the benefit of agriculture and commerce in time of peace.

"The people at large have taken a great interest in the Government weather bureau, and desire to see its work continued and its predictions improved. They would be glad to see an extension of scientific study in its offices, for on such study all its chances of better success depend. The opening of the third period in its history will, therefore, be watched with the deepest interest. The needs of the service must be thoroughly and deliberately considered. Immediate action, resulting in the appointment either of a military chief or of a civil director, would be deprecated on all sides, for the interests involved are too great to be endangered by hasty decision. Moreover, there is a very general desire, on the part of meteorologists and of scientists generally throughout the country, that they should at least be heard in the matter before decision is reached, so that whatever plan of future organization is adopted shall be based on full and open discussion. Deliberate action and authorized opportunity for consideration of scientific as well as of military methods are, therefore, of the first importance. It should be the earnest effort of all who have watched the development of the signal service thus far to secure these guaranties of its further progress."

Compound Engines.

MR. V. BORRIES, it will be remembered, says *The Engineer*, is associated with Mr. Worsdell in compound engine work. The following statement from his pen as to the advantages and *rationale* of compounding is taken from *Glaser's Annalen*, published in Berlin:

"The advantage of compound working may be stated as follows: In the ordinary locomotive, with slide valves and narrow ports, it is not very desirable to attempt more than three to four-fold expansion, and the steam is passed off at a pretty high temperature, which is utilized somewhat in the second cylinder of the compound machine. Furthermore, the shell of the cylinder naturally takes the mean temperature of the steam passing through it; and as the temperature of the expanded steam falls below this it absorbs, before passing into the stack, a certain amount of heat from the cylinder shell which has to be replaced from the entering steam. This operation in a compound machine takes place in the low-pressure cylinder only, since the heat absorbed by the steam from the other cylinder is utilized in the low-pressure one. The steam lost in the clearance spaces and in the leakage around the piston of the high-pressure cylinder is also utilized, and a more uniform pressure on the piston is attained for the same degree of expansion.

"With steam cut off at one-quarter stroke, the greatest force of the steam is exerted where it is least effective and produces more friction, while if we get the same expansion by cutting off at one-half and expanding into another cylinder, the action of the steam is obviously more effective.

"By the possibility of expanding two-fold, while giving full steam to one cylinder, and obtaining an eight-fold expansion by cutting off at one-fourth, greater and more profitable range is given to the engineman in graduating his cut-off.

"With all these theoretical advantages, a practical average saving of fuel of 17.1 per cent. over locomotives of similar construction with ordinary cylinders has been attained. This result is the average of the collective working of three compound engines—respectively, freight, passenger and omnibus engines—working against seven different ordinary engines of similar class and weight, for periods of from three to nine months each.

"The boiler pressure carried on the compounds was 180 lbs., while that of the other engines varied from 135 lbs. to 180 lbs.

"The valve gear of these compound engines is just as simple as that of ordinary engines, the links for both cylinders being set by the same movement of the lever and not capable of separate adjustment.

"It is to be noted that in this system both slides receive together the pressure usually thrown upon one for a given quantity of steam used, causing less wear on the parts.

"Since the pressure on the pistons is more uniform throughout the stroke, and since the work is more equally divided between the pistons, these engines run very steadily; and this, with the smaller quantity of fuel burned, makes the repairs for machinery and boiler less than usual, in spite of the high boiler-pressure carried.

"The great expansion of the steam diminishes the intensity of the blast so much as to cause little or no spark throwing from the stack.

"To ascertain the necessary diameter d, of the large cylinder, Mr. Von Borries uses the following formula:

$$d^2 = \frac{2\,Z\,D}{p\,h}$$

"Where Z = tractive force required = 0.14 to 0.16 of the adhesion weight—when allowance is made in Z for the external engine friction, taken as equal to that of the cars.

"D = driving-wheel diameter, inches.

"h = stroke, inches.

"p = mean effective steam pressure—after deducting internal machine friction—per square inch.

"This latter depends upon the comparative cross sections of the two cylinders, and from experience and indicator experiments may be taken as follows:

	Relative section of cylinders.	p in per cent. of boiler pressure.	p for 180 lbs. in boilers.
Large engines, with tenders..	1:2	0.45	81.0 lbs.
Tank engines,...............	1:2.25 1:2.3	0.42	75.6 "

"Engines for long, heavy grades should be proportioned for Z = 0.16 adhesion weight, that they may have large enough cylinders; but 0.14 is usually enough.

"For passenger and express engines the size of the small cylinder may be made on the usual basis, and the large cylinder of double the section, and the boiler pressure increased 15 lbs. to 30 lbs.

"It is desirable in general to proportion these engines so that they may ordinarily work at one-fourth to one-third cut-off.

"A compound engine of this kind will pull, according to Mr. Von Borries, 10 to 15 per cent. more than an ordinary locomotive with the same heating surface and grate area.

"The receiver between the cylinders is best constituted by a pipe passing, if possible, through the smoke-box, and if not, over the boiler, lying close to it and well protected from cooling off. The cubic contents of this connection pipe should not be less than that of the small cylinder, and it is better larger, in order to avoid too unequal back pressure on the small piston.

"In order to give as much power as possible for starting, it is necessary to bring pressure at once on both pistons. For this purpose an ingenious stop-valve has been contrived by Mr. Von Borries. This valve is placed in the connection-pipe between the cylinders, and when the throttle is first opened a small port gives entrance to steam behind the valve and holds it to a seat over the exhaust from the small cylinder, and allows the pressure from the boiler, reduced, however, by the small area of the port, to take effect on the large piston. As soon as the exhaust port of the small cylinder opens, the steam from this overpowers the pressure behind the stop-valve and forces it back to a seat, closing the small extra port above referred to. This port is then kept closed by the boiler pressure itself, acting on a balancing device until opened by the driver by means of a special lever.

"Before opening the throttle, therefore, the engineer throws this lever over, and the opening of the throttle lets boiler steam

into both cylinders, which access is suspended automatically as soon as the exhaust of the small cylinder opens.

"The steam from the stacks of these engines is somewhat damp. This is not a sign of foaming, but an indication of the more perfect extraction of the heat and power from the steam.

"These engines make plenty of steam, particularly in fast running. The exhaust nozzles can be made $\frac{3}{8}$ inch to $\frac{5}{16}$ inch wider than usual, owing to the more uniform quality of the blast, with its low pressure and two gentle impulses instead of four violent ones in every revolution.

"Mr. Von Borries sums up the chief advantages of the compound engine very sensibly as follows: Better production of steam through more uniform blast, and better application of it through higher expansion and the possibility of getting a good expansion with very high-pressure steam, without unduly increasing the friction.

"From the uniformly good results attained by the three different methods of Mallet in France, Webb in England and Von Borries in Germany, and similarly good results by Worsdell in England, with an arrangement similar to Von Borries, it would seem as if the failure of the system to work on the Boston & Albany must have been due to an unsatisfactory application.

"The adverse experience with compound locomotives on the Kaiser Ferdinand Northern Railroad, of Austria, which by its own account lay entirely in the heavy repairs, seems to have been due to their injudicious use of the Mallet system. In this there are two sets of valve gear, to permit working either simple or compound; and the road in question found that in working high pressure on both cylinders the unequal pressure racked the engine-frame and working parts out of order.

"This high-pressure working, according to Mr. Von Borries' experience, is only necessary on the starting stroke, and he gets over the unequal pressure by contracting the throttles to the low-pressure cylinder."

An American Yacht for England.

THE Boston *Transcript* says: "The designs for a schooner yacht for Mr. Potter, a wealthy resident of London, England, in the hands of Mr. D. J. Lawlor, of East Boston, are nearly completed. Mr. Lawlor's success in designing fast vessels, notably the famous pilot boat *Hesper*, now in Boston waters, led to his receiving the English commission named above, visitors from the mother country having spread his fame among their fellows nautically inclined. The new yacht is to be 120 feet over all, 100 feet from stem to stern post, 24 feet beam and 12 feet draught. Her lines are finer than those of the *Hesper*, and her bow is longer. The area of her midship frame is 124 feet; area of load line, 1,551 feet; coefficient of midship frame, .54. Like the *Hesper*, she will be a thorough sea-going craft, roomy and comfortable, and calculated for great speed. The area of canvas she is to carry has not yet been determined; neither has the yard where she is to be built, whether British or American, been selected."

New Hudson River Steamboat.—A new iron steamboat for the Albany Day Line, on the Hudson River, was recently launched from the yard of the Harlan & Hollingsworth Company, at Wilmington, Del. The new boat is 300 feet long between perpendiculars, and 40 feet beam; her deck dimensions are 315 feet long and 75 feet beam. She will draw 6 feet of water, loaded. The paddle wheels will be 30 feet diameter, with feathering floats 12 feet 6 inches long by 44 inches wide. The engine will be of the ordinary walking-beam pattern, the cylinder 75 inches diameter and 12 feet stroke. There are three steel boilers of the cylindrical return-flue pattern, and the usual boiler pressure will be 60 lbs. The boat is to be ready for the summer travel.

Manufactures.

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

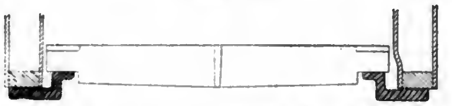
(Continued from page 88.)

CHAPTER V.

GRATES.

With very few exceptions, the fuel used in the early locomotives in this country was wood. This could be burned successfully with an ordinary "plain" grate, as it was called, consisting of narrow bars with spaces about $\frac{1}{2}$ inch wide between them. Figs. 64 and 65 show a grate of this kind, which was

Fig. 64.



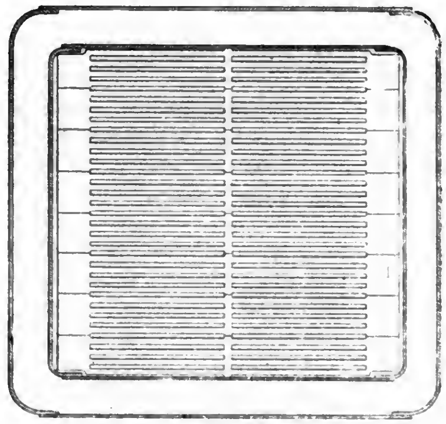
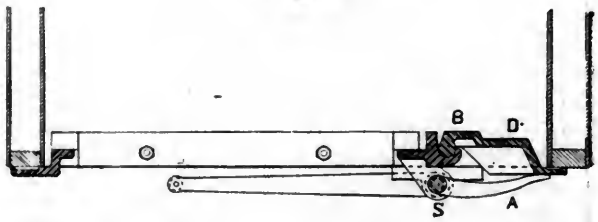


Fig. 65.

Fig. 66.



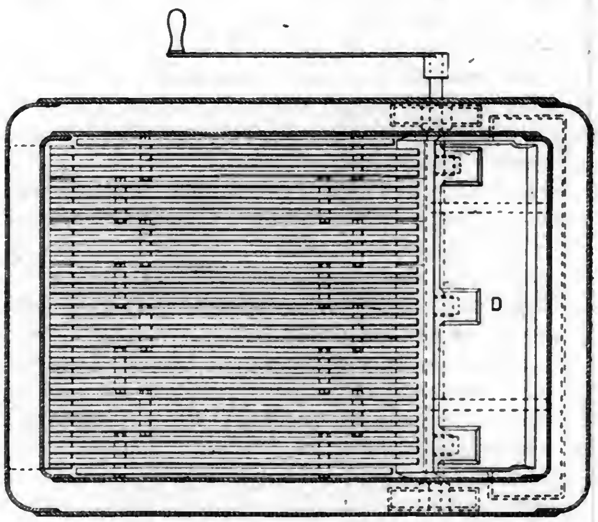


Fig. 67.

used in 1840. The bars were made of cast-iron, the material of which locomotive grates are almost universally made in this country. Figs. 66 and 67, however, represent a grate

made of wrought-iron bars, bolted together in groups of four bars each. The use of wrought-iron bars is, however, an exception to the general practice in this country. The grate shown in the figures last referred to has a drop-door D at the front end. This is hinged at B, and is held up by the arms

to provide locomotives with what are called shaking grates for "clearing the fire." A number of different grates of this kind, which have been applied to locomotives at the Rogers Works, are shown by the following engravings :

Figs. 68 to 71 represent the Allen & Hudson grate, which

Fig. 68.

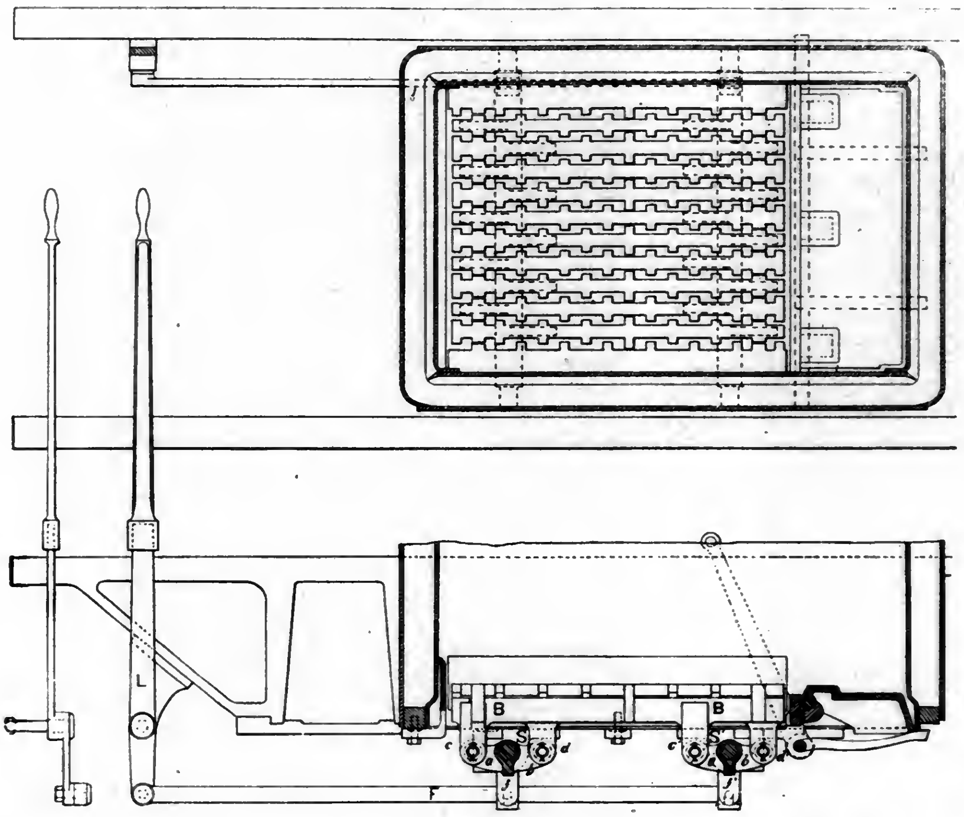


Fig. 69.

Fig. 72.

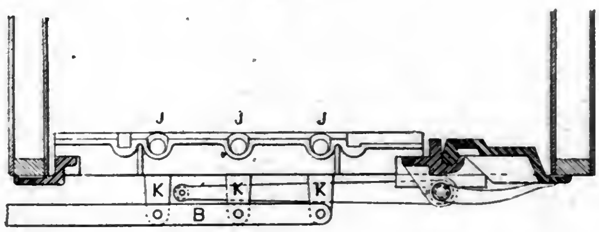
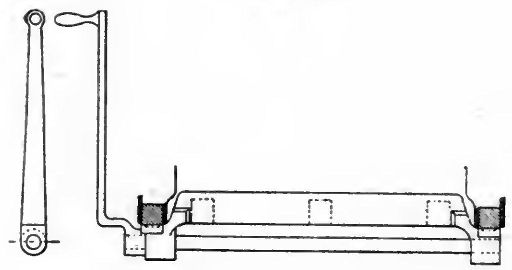


Fig. 70.



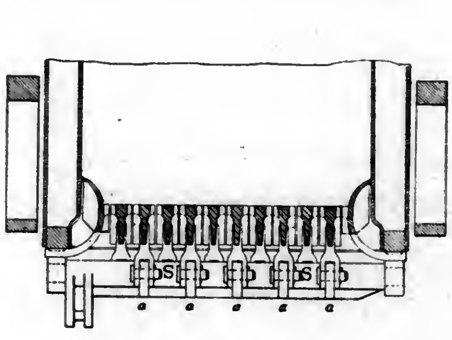


Fig. 71.

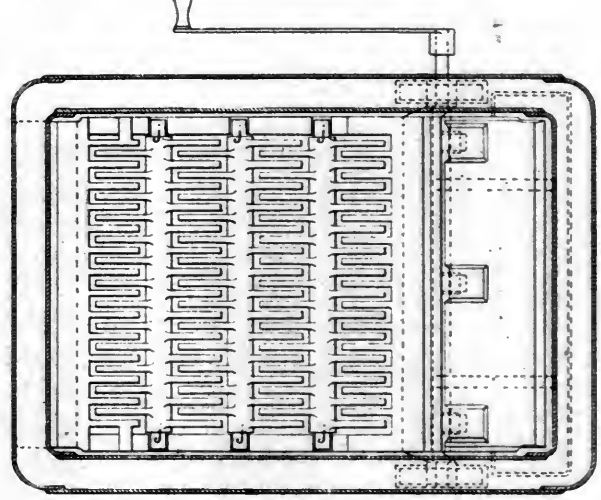


Fig. 73.

A A, on the shaft S. To drop the door, the shaft is turned by the lever on the end of the shaft, which lowers the arms A A and allows the door to fall.

As much of the bituminous coal in this country contains a great deal of material which causes it to clinker, or otherwise interferes with its free combustion, it has been found essential

was patented by Albert J. Allen and William S. Hudson in 1858. The grate is composed of a series of cast-iron bars with lugs on their sides, as shown in the plan. Underneath the bars are two cast-iron rocking-shafts, S S', which have arms *a a'* and *b b'* on their opposite sides. Each grate-bar has two projections *c c'* and *d d'* on its under side. To make it

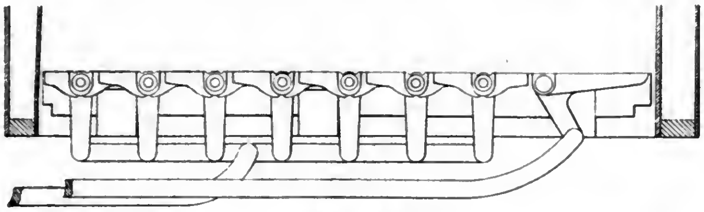


Fig. 74.

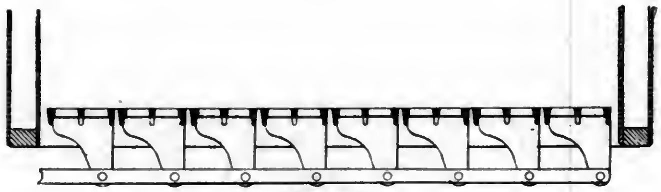


Fig. 76.

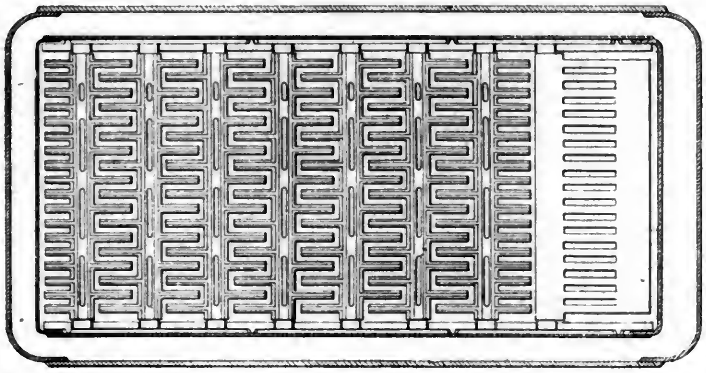


Fig. 75.

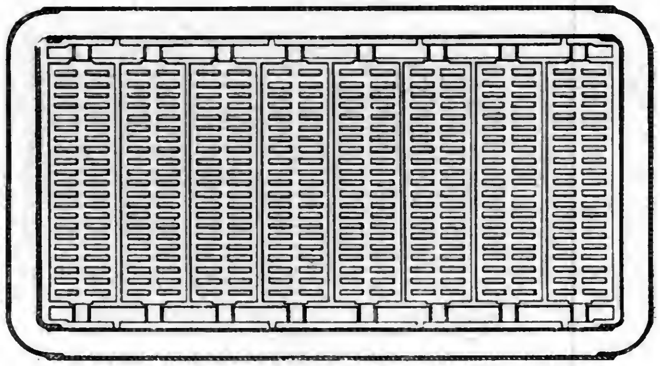


Fig. 77.

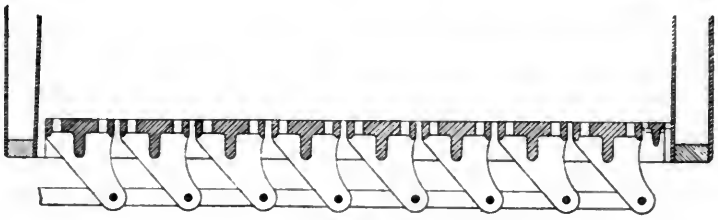


Fig. 78.

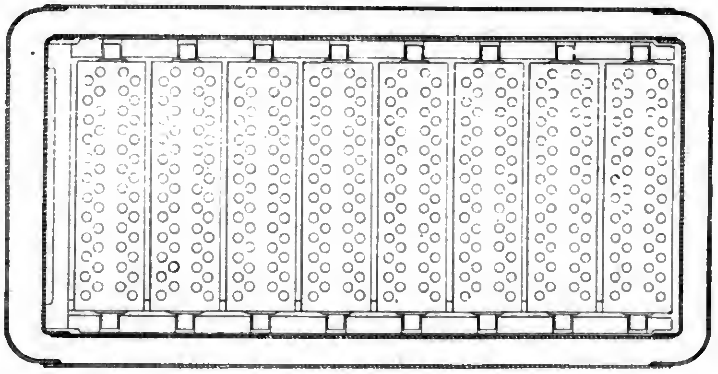


Fig. 79.

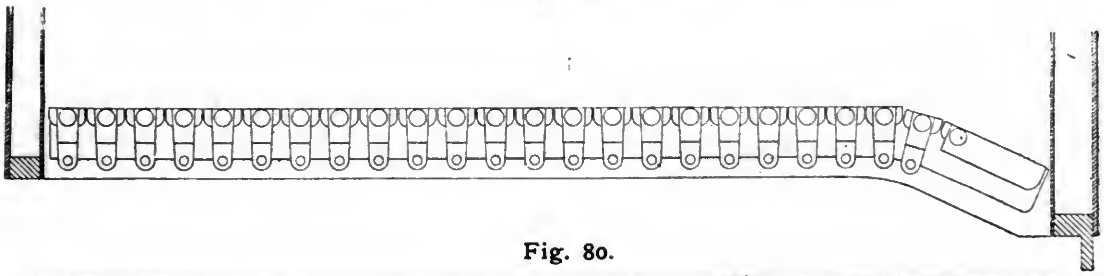


Fig. 80.

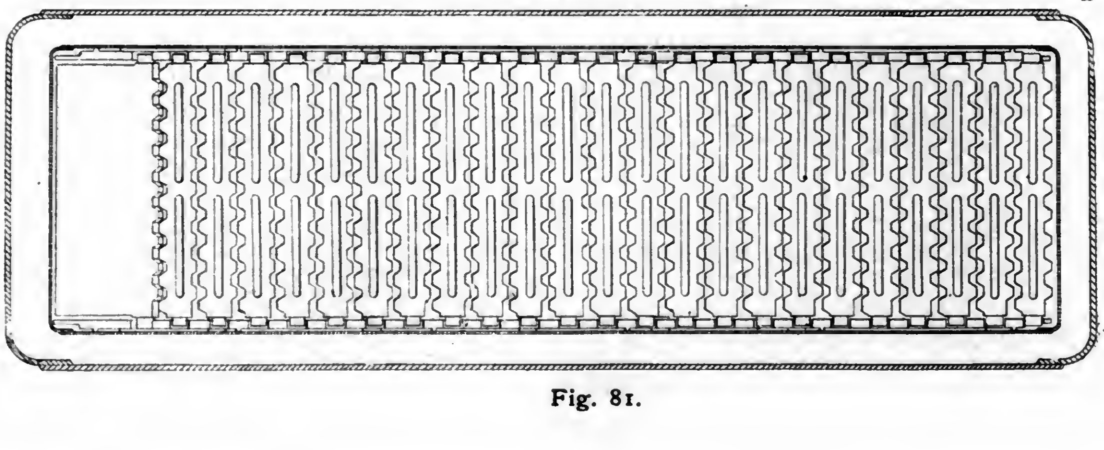


Fig. 81.

clear how the grate operates, it may be explained that the bar B B, shown in Fig. 69, has the two projections *c c'* attached to it, and that the projections *d d'* are attached to the bar next to B B. The projections *c c'* are connected by pins to the arms *a a'*, and *d d'* are attached to the arms *b b'*. It is obvious then, that when the shafts S S' are rocked, that the arms *a a'* will rise, and *b b'* will fall simultaneously, and *vice versa*, and that the grate bars connected to these arms will have a corresponding movement. As the alternate bars which compose the grate are connected to the arms on the right side of the shafts S S, and the bars between them are connected to the arms on the left side of the shafts, it is plain that the working of these shafts has the effect of giving a limited upward and downward movement to the bars, in which each bar ascends as the next one on either side of it descends, and *vice versa*. This movement has the effect of breaking up the clinkers or other foreign or residuary matter that may collect upon the grate, and which tend to choke the draft between the bars, and to cause such matter to work down between the bars into the ash-pan, and also serves to evenly distribute the fuel over the grate.

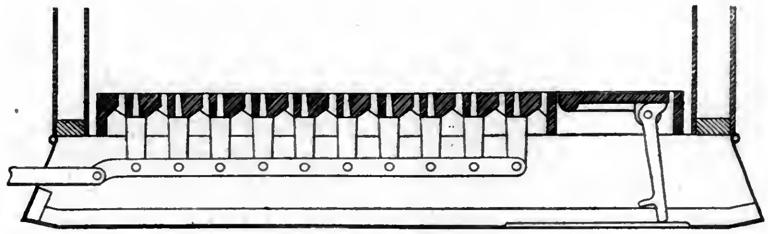


Fig. 82.

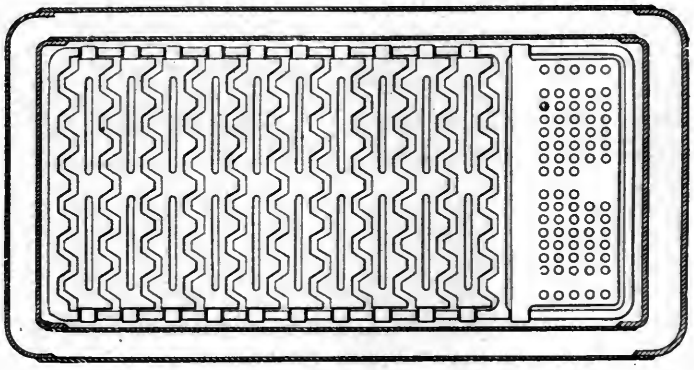


Fig. 83.

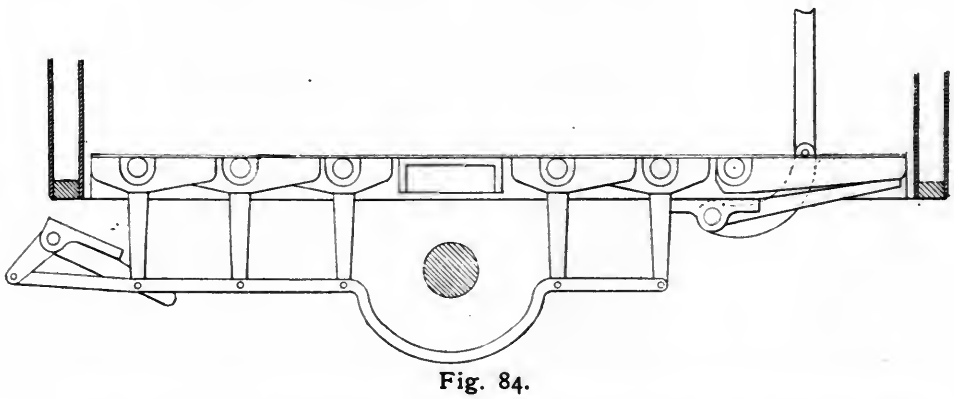


Fig. 84.

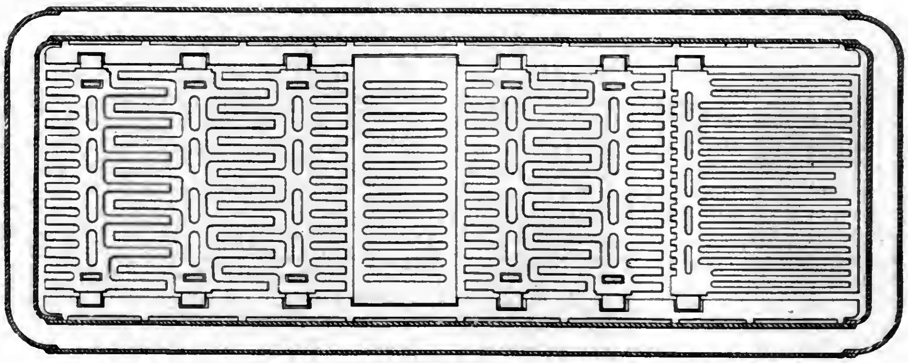


Fig. 85.

The working of the shafts S S' is effected by means of the

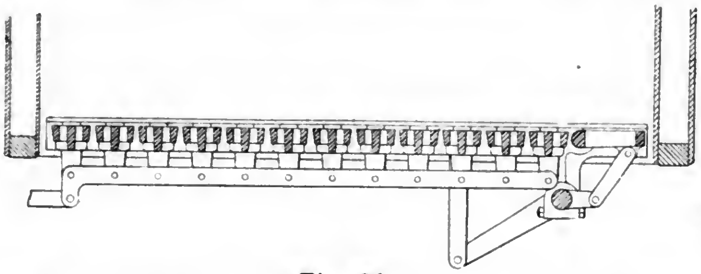


Fig. 86.

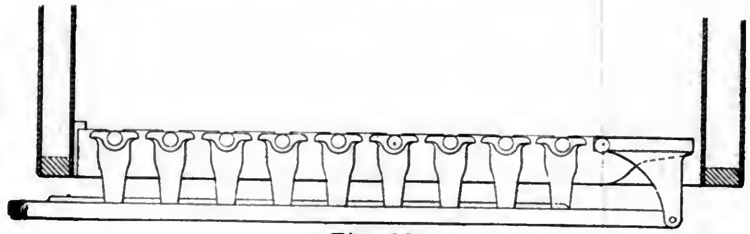


Fig. 88.

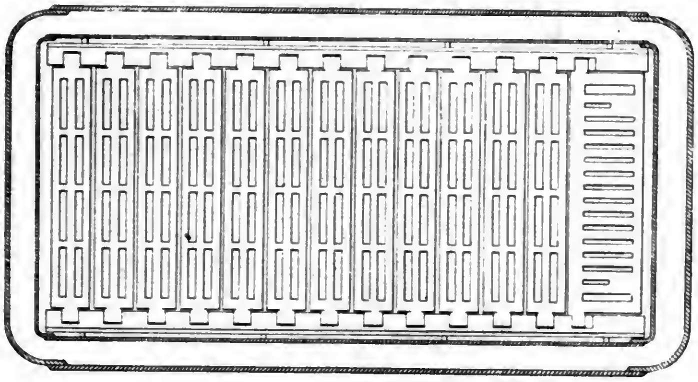


Fig. 87.

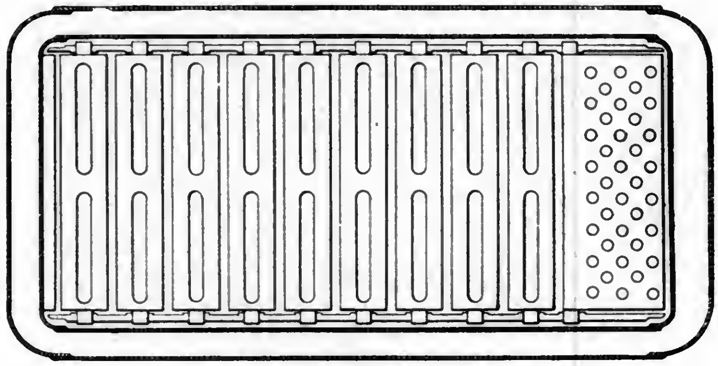


Fig. 89.

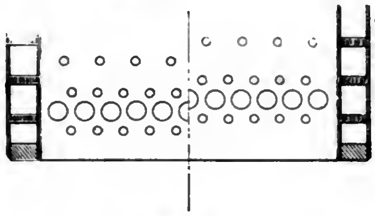


Fig. 90.

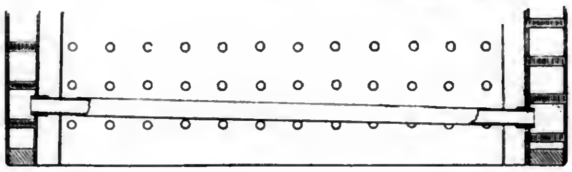


Fig. 91.

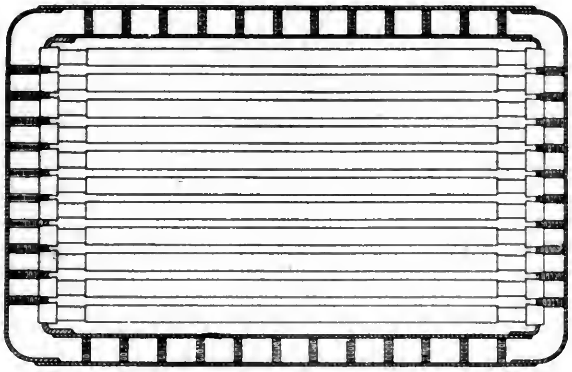


Fig. 92.

lever L, which is connected by a bar, F, to vertical arms, *f f'*, attached to the under side of the shafts. The grate is also provided with a drop door.

Figs. 72 and 73 represent what is called a "finger" grate, which consists of cast-iron shafts, with projections or fingers on each side. These shafts rest in journals, *j j j'*, and are rocked by a lever (not shown in the engraving) and bar B, the latter connected to vertical arms, K K K, attached to the shafts. It is obvious that, as the shafts are rocked, the fingers on one side rise, and those on the opposite side fall, and that the effect will be to thoroughly shake up the fire. Figs. 74 and 75 represent another form of finger grate. Both the forms illustrated were first used in 1860.

Figs. 76 to 89 represent various forms of "rocking" grates as they are called. These have transverse grate bars, with journal bearings at each end, similar to those of the finger grates. The bars are rocked on these journals, which has an effect similar to that of the finger grate in stirring up the fire. The construction and action of these grates will be obvious from the engravings.

For burning anthracite coal, the water-tube grate is almost universally used. The form used on the Philadelphia & Reading Railroad is shown in Figs. 30 and 31. The tubes are put in as shown in Fig. 31. Solid bars, B B, are substituted for every fourth tube. These bars pass through thimbles, T, Fig. 30, in the back end of the fire-box, and can be drawn out through this thimble to clean or remove the fire.

Figs. 90, 91 and 92 represent a water grate, recently introduced, to burn bituminous coal.

(*To be Continued.*)

Legislative Hearings on Car-Heating.

MASSACHUSETTS.

The Railroad Committee of the Massachusetts Legislature gave a public hearing on the question of car-heating in Boston, February 10. The Railroad Commissioners, a number of railroad officers, patentees of heaters and others were present.

Col. Stott, of Lowell, appeared on behalf of persons who had petitioned for a law regulating methods of heating cars, and urged the necessity of legislative action.

Mr. James Emerson, of Holyoke, then described his method of heating cars by steam taken from the locomotive, and gave some facts as to its operation on the Connecticut River road. He claimed that it is now beyond the experimental stage. On a train with 300 passengers it is cheaper to heat from the engine than by stoves. Eight seats additional are gained by removing the stoves, and the capacity thus gained is worth more than the fuel. A train of 15 cars would be reduced to 13 and give the same seating capacity, and an engine can draw and heat 13 easier than it can draw 15.

Mr. Baker then appeared for his heater, and claimed that the steam system is practicable only on small trains and short runs. He claimed that heaters can be made entirely safe by casing.

General Manager Furber, of the Boston & Maine road, said that he did not believe in heating by steam from the engine; but he believed cars could be heated by hot water taken on at the stations.

The Gouge, Sewall, Thayer, Gold, Johnson, Chase, Burnhem and White systems of heating were explained to the Committee.

NEW YORK.

The New York Legislature on February 7 passed the following resolutions:

"*Resolved*, That the Board of Railroad Commissioners be and the same hereby are requested to report with all convenient

speed to this Legislature, whether there is any feasible method of heating and lighting the cars on passenger trains other than that now generally in vogue, whereby, in case of accident, the loss of life from fire, now oftentimes so severe, can be avoided; and if so, what legislation, if any, is needed to secure the adoption of such improved methods of heating and lighting by the various railroad companies subject to the laws of this State; and, also, that the said Board be requested at the same time to report any other and further measures or suggestions for practically increasing the security of life and limb in railroad travel, as may seem to it proper and desirable in the premises.

"*Resolved*, That the Railroad Commissioners be requested to report to the Assembly what legislation is necessary to compel the use of such methods of heating railroad cars as will ensure safety from fire in case of accident."

In pursuance of the above resolutions, the Board held a public hearing on Wednesday, February 16, upon the questions of improved methods of heating and lighting in railroad passenger cars. At this hearing there were present a number of representatives of various systems of heating cars.

Mr. Sewall explained his system of heating by steam taken from the locomotive, which is now in use on the Maine Central.

Mr. W. C. Baker described his heater, and claimed that the use of steam from the locomotive was not practicable.

Mr. J. B. Brady, of the Smith & Owen Heater Company, described that heater, and claimed that it could not be broken in any ordinary accident.

Mr. Medway (Master Mechanic of the Boston, Hoosac Tunnel & Western) said that they had tried a heater suspended under the car, and found it very unsatisfactory.

Mr. T. C. Shepard, of Albany, presented a plan by which he proposes to heat cars and light them with electricity. The idea is to have a dynamo in each car to be run from the axle of one of the wheels. By the current, water is heated so as to warm the car, and there is a storage battery in the plan to guard against long stops.

Mr. J. W. Cloud (Superintendent of Motive Power, New York, Lake Erie & Western) did not think any car could be properly heated and ventilated unless cold air is heated before it is brought in from the outside. The present system of heaters or stoves can be made comparatively safe. The trouble is that the heaters are built like egg shells and break too easily. Steam heating from the engine was also practicable, but it would take too much power to run a dynamo from a car-axle. It would be twenty times as great a demand on the engine as to take steam from it to heat the cars. The trouble with steam-heating was that hot water condenses in the rubber hose and spoils it. Any change in the system of car-heating would require additional plant and expense at terminal stations.

The discussion then turned on the lighting of cars. Mr. Rogers held that fires were just as frequently started by lamps and candles as by hot coals. Mr. Smith said a chemical electric battery was being successfully used for this purpose on the Boston & Albany road.

Mr. R. C. Blackall (Master Mechanic, Delaware & Hudson Canal Company,) offered the Commission the use of a car for experimental purposes, and the offer was accepted.

The investigation will be continued by the Commission, before a report is made to the Legislature.

The French Railroad Jubilee.—Active preparations continue to be made for the celebration of the 50th anniversary of the establishment of railroads in France.

The promoters of this jubilee have, however, recently received a check, which may prove a very serious one, to the projected celebration. Six of the great railroad companies of France have declined to take part in the proceedings at Vincennes in 1887. They are unanimous in regarding the proposed celebration as contrary not only to historic truth, but to the interests of the Exhibition in preparation for the 1889 centenary. They state that the first railroad in France was made previous to the year 1837, and to celebrate in 1887 the fiftieth year of their railroad system would be to give an impression contrary to truth; that other nations had been notably in advance of France. Further, to organize an especial exhibition in relation to railways and the divers industries connected with them, only two years previous to the great industrial manifestation of 1889, would be to rob the latter of a part of its attraction and *eclat*. The six great companies consider it their duty to reserve all their efforts for the national fêtes of the centenary. The Institution of Civil Engineers of France has declined to support this scheme, and it is reported that the Minister of Public Works has also refused it his support. It is also charged that the proposed celebration will really have no technical interest, and that the supporters of the scheme have not had engineering prominently in view.

New Inventions.

Patents.

February 19, 1887.

THE United States Patent Office passed to issue in the month of December, last, 1,637 patents, and in the month of January 1,448; or, for the two months in question, 3,085 patents.

Examining these patents for the purpose of making a comprehensive exhibit of all those covering devices intended for use on a railroad of any kind, we find that 221, or something more than 7 per cent. of the entire lot, are properly to be included in such exhibit.

With the understanding that, where there is no specific indication to another effect, the appliance designated is intended, primarily, for use on standard-gauge surface railroads operated by steam locomotives; the nomenclature used in the subjoined table sufficiently suggests the class of railroad service for which the invention named is intended.

Our inventors, then, in the brief period of eight weeks, have added to the stock of contrivances from which railway managers seeking improved appliances may select, the eleven score devices scheduled below:

Ash pan	1
Axle	1
Axle-box	3
Bogie—loose wheeled	1
BRAKES—TRAIN BRAKES—	
Pneumatic	1
Fluid pressure	2
Electro magnetic	1
Automatic	11
Locomotive	1=16
Brake attachment—hand	3
Brake-block-holder	1
Brake and wheel dresser	1
Brake-shoe	2
Cable railways	3
Cable railway-switch	1
Cable railway cable tunnel	1
Cable-grip	5
Car-couplings	41
Link-lifter	1
CARS—	
Box-car	1
Stock-car	5
Boudoir-car	1
Street-car	5
Hand-car	1=13
Contractors' dump car	1
Car lamp	2
Car-lighting apparatus, electrical	1
Car-heating apparatus	2
Car-door fastener, freight	1
Car-door, freight	3
Car-platform	1
Car-steps	2
Car-truck	2
Car-wheel	3
Wheel-measuring device	1
Car-seat	2
Car-spring	1
Car-mover	1
Car-starter	4
Car-pilot and guard	1
Car-replacing apparatus	1
Curve for street-road	1
Cattle guard	1
Exhaust mechanism	1
Foot-guard for frogs	1
Frog	1
Fire-door operating-mechanism, steam	1
Feed-water heater	1
Gate for car-platform	1
Gate for Crossings	3
Journal-brass	3
Journal oiler	1
Lathe for wheels and axles	2
Locomotive	1
Locomotive furnace	2
Locomotive boiler	1
Locomotive spring	1
Motor, for cars	1
Nut-lock	2
Pinch-bar	0
Railway, elevated	1 2
Switch casting for	1
Railway crossing	2
Railway operation at way stations	2
Railway, street, post for track support	3
Rail-joint	3
Rail-fastening	7
Rail-repairing mechanism	1
Rail chair	1
Seat for freight-cars	3
Snow-plow and scraper	1
Snow-plow	1
SIGNALS—	
Train	3
Road	8=11
Signal-lamp	2
Signal-fusee	1
Smoke-stack	1
Spark-arrester	1
Spike	1
Switch	4
Switch-plate	1
Switch stand	1
Tie, metallic	5
Tie, for cable road	1
Turn-table	1
Track-laying apparatus	1
Tamping-bar	1
Truck-assembling apparatus	1
Traction increaser	1
Ventilating apparatus for cars	2
Valve-gear	1
Wheel-truer	1

As promising to serve well in a direction in which improved practice is very desirable, we mention the steam-actuated furnace-door operating device, Patent No. 354,631. With this device in use the locomotive fireman, in order to open or close his fire-door, has only to press his foot upon a conveniently-placed pedal.

The fire-door shown in the drawings in this patent has two leaves, or valves, closing upon a medial vertical line. We suggest a division of the door upon a horizontal line across the doorway, which line may be somewhat above the middle of the fire-hole. With a door thus arranged, the edge of the lower leaf being suitably beveled, the fireman may, with his broom, send the sweepings of the foot-board directly into the fire-box; moreover, with this suggested arrangement the space necessarily left free for the lateral swinging of a door (or doors) hinged at the side, may be otherwise utilized. But, why not hinge the whole door at its upper edge; or, indeed, why not slide the whole door sidewise?

Another device deserving attention is the railroad crossing, patent No. 355,156.

The array of coupler men is fully up to the average—in number and in ingenuity. Very many of these patentees have, like

many of the army heretofore passed in review, gone to work in entire disregard (or ignorance) of the fact that a car-coupler, if it is to be of any *present* value, must be effective in coupling with the ordinary link-and-pin hand-smasher. J. M. G.

Proceedings of Societies.

Omaha Railway Club.

A NUMBER of the employés of the Union Pacific Railway have formed an organization known as the Omaha Railway Club, for the purpose of discussing matters connected with the railroad service. At the first meeting a committee was appointed to prepare a constitution and by-laws. The intention is to meet monthly in Omaha.

Cleveland Civil Engineers' Club.

A MEETING of this Club was held in Cleveland, O., February 8, at which nominations were made for officers to be voted for at the March meeting.

Mr. W. W. Christian, of Norwalk, O., then read a paper on Piping Natural Gas Long Distances, which was followed by a brief discussion.

Engineers' Club of Kansas City.

THIS Club was organized at a meeting held in Kansas City, Mo., February 6. It starts with thirty-three members, and its regular meetings will be held on the first Monday of each month.

The officers of the Club are: William B. Knight, President; J. A. L. Waddell, Vice-President; Octave Chanute, Clift Wise, Directors; Kenneth Allen, Secretary, Treasurer and Librarian.

Iowa Society of Civil Engineers.

THE annual meeting of this Association was held at Des Moines, Ia., February 3. The reports of the officers show that there are now 16 members.

The following officers were elected for the ensuing year: President, William Steyh, Burlington; Vice-President, M. Tschirgi, Jr., Dubuque; Secretary, F. A. Macdonald, Cedar Rapids; Treasurer, A. W. Swanitz, Cedar Rapids; Executive Committee, Conrad Eimbeck, W. W. Young.

Committees were appointed to arrange for the next meeting, and to take steps to extend the membership. It was decided to hold the next meeting at Des Moines on April 13 next.

Mr. Tschirgi read a long and interesting paper on City Engineering, describing the many important duties devolving upon the Engineer of a small city and the wide range of work expected from him. The Society then adjourned until April next.

Michigan Engineering Society.

THE eighth annual convention of the Michigan Engineering Society was held in Grand Rapids, Mich, January 25, with a large attendance.

The first papers read were a report on the Tamarack Mine by Charles D. Lawton, State Mining Commissioner, and a description by President Davis of the standard measure built in the hall of the main building of the State University at Ann Arbor. This rod is 103 feet long, is made of pine, and so arranged that it will remain in an equable temperature continuously. The measure was "standardized" by a 6-feet steel Coast Survey rod, and will be the future standard measure for engineers' tapes and chains in Michigan.

On the second day several papers were read and the following officers elected: President, George E. Steele, Traverse City; Vice-President, F. Guild, East Saginaw; Secretary, H. Hodgman, Climax.

Central Railway Club.

THIS Club, which was organized at a meeting held in Buffalo, N. Y., January 26, is the outgrowth of the meetings of master car-builders which have for several years been held in Buffalo, from time to time, to discuss the rules of interchange and settle disputed points. It has been agreed by those attending the meetings that a new Club was desirable, to be organized on much the same plan as the Master Car-Builders' Club in New York, the New England Railroad Club in Boston and the Western Railway Club in Chicago, and to fill up the wide gap now existing between the Eastern and Western organizations. The result is the Central Railway Club.

At the meeting of January 26, a constitution and by-laws were adopted, and all the necessary machinery put in motion. The officers chosen were: President, R. H. Soule, Buffalo, N. Y.; Vice-President, T. Sullivan, St. Thomas, Ont.; Secretary and Treasurer, E. Chamberlain, Buffalo, N. Y.; Executive and Financial Committee, R. H. Soule, E. E. Chamberlain, W. F. Turreff, F. B. Griffith, John Kirby and R. C. Blackall.

Meetings are to be held at Buffalo on the fourth Wednesday in March, May, July and October.

The establishment of a museum of railroad machinery and appliances is proposed, but no action has yet been taken on this point.

New England Water-Works Association.

A REGULAR meeting was held in Boston, February 9. Mr. Hiram F. Mills spoke of the newly organized State Board of Health (of which he is a member) and of what it proposed to do in matters which have especial interest for the Association. All inland waters in Massachusetts are now under the care of this Board, and no plan for water-supply or for sewage disposal can be carried out without first being submitted to the Board for approval. The Board has asked for an appropriation of $30,000, and proposes to expend one-third of this amount in having chemical and microscopical examinations of some 2,000 different samples of water, collected from all over the State. For one year samples are to be collected monthly, and after that time semi-annually. The first examination will have especial importance, as furnishing a standard for future comparisons.

Mr. Mills concluded by asking the members of the Association to co-operate with the State Board in protecting and improving the quality of the inland waters of the State.

Mr. Mills' remarks were followed by questions and discussion from Messrs. Tidd, Fitzgerald, Holden, Rotch, Darling and President Rogers.

Prof. George F. Swain, of the Massachusetts Institute of Technology, read a paper upon the Influence of Forests upon Rainfall, which will be published in the Journal of the Association.

The paper was briefly discussed by Desmond Fitzgerald, C. E., and Commissioner W. H. Hawes, of Fall River.

A paper by Albert F. Noyes, C. E., of Newton, upon Driven Wells, was postponed until the next meeting, on the second Wednesday in March.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the Club House in Philadelphia, January 22, President T. M. Cleeman in the chair; 25 members and 1 visitor present. The Secretary presented, for Mr. Conway B. Hunt, a paper on Hydraulic Dredging Machinery.

This paper mentions the early application of the principle of hydraulic dredging, that is, the mixing of dredged material with water, and then removing the mixture by suction or otherwise; and after referring briefly to the Roy, Stone and Bowers dredges as typical machines, describes in detail the Von Schmidt dredge. Two of these dredges are engaged on the improvement of the Potomac River at Washington, D. C., under the United States Government. In conclusion, it is noted that the devices and details of hydraulic dredging machines are the subjects of numerous patents, and their most efficient combination may be long deferred. The large number of machines that are still in the experimental stage of development would indicate that the best results attainable from this class of dredges have not yet been accomplished.

The Secretary presented, for Mr. W. E. Hall, a paper on Controlling Expansion in Locomotives.

Mr. E. S. Hutchinson described the Anderson Process of Water Purification on a Large Scale, as given by the inventor, and as in use in several European cities. The water, after settling, is forced through a revolving purifier, which consists, essentially, of a wrought-iron cylinder, mounted on hollow trunnions, serving for inlet and outlet pipes. The curved ledges, running lengthwise of the cylinder on the inner surface, scoop up and shower down through the current of water fine borings of cast iron. By the combined motions of the cylinder

and of the water current, every portion of the water is brought into contact with the iron, the particles of which are kept constantly bright by friction against the sides of the cylinder, against each other and the water.

Prof. L. M. Haupt then, by request, entered upon a discussion of the special questions involved in the improvement of New York harbor and of the proposed government work there.

Prof. Haupt submitted results of tests of the Tensile Strength of Canvas for the Club *Reference Book*. The club then adjoined.

A regular meeting was held at the Club House in Philadelphia, February 5th, President T. M. Cleemann in the chair; 26 members present.

The Secretary presented, for Mr. Morris P. Janney, a note upon the Differential Gauge as used at Blast Furnaces. The appliance was devised by Messrs. Taws & Hartman, engineers, Philadelphia, for the detection of irregularities in the working of blast furnaces in the neighborhood of the tuyeres. "The lower portion of a blast furnace, where the blast enters, is called the crucible. The blast passes through, generally from three to seven, and sometimes more, tuyeres, which are water-cooled castings placed in the wall of the furnace to prevent cutting. Although the blast is supplied to these tuyeres from one main, the air does not enter all of them at equal velocity at all times, and sometimes stops altogether at one or more of them without the furnace-keeper being able to tell by observation whether there is anything wrong or not. When the blast ceases to enter a tuyere through an obstruction coming in front of it, or the nozzle becoming clogged, it should be immediately opened by mechanical means until the blast enters again at the maximum velocity. Until the introduction of the little instrument I am about to describe, the trouble was to tell when the obstruction was removed or even existed; as a tuyere in this condition will frequently, for hours, appear about the same to the eye as a good, clear one. Also, if the blast be checked for any considerable time at one or more points, the rate of coal consumption diminishes as the volume of air lessens, causing slower descent of the charge at this point, and either forming a scaffold or giving a very good opportunity for one to form above the obstructed tuyeres, which, in the large majority of cases, will result in irregular and reduced yield of iron, and possibly, in the end, permanent obstruction of the whole furnace. The instrument consists simply of a small glass U tube, or its equivalent, filled to proper point with mercury. This gauge differs from the ordinary blast gauge in having both ends connected to the blast pipe at different points, instead of having one end only attached. Between the two points of connection there is a slight obstruction placed in the blast pipe leading to each tuyere, so as to make a difference in the pressure at the two points of connection. When the tuyere is clear, the difference of pressure is greatest and the mercury in gauge stands at different levels in the two legs. If a tuyere becomes obstructed in any way there is less and less difference in the mercury level, until, if the obstruction is considerable, it becomes level, thus indicating a very much reduced flow of air through the tuyere. Pipes are connected with each tuyere and all conveyed to same location where they are attached to separate gauges, and all the keeper has to do is to glance at the gauges, when they at once show the condition of the nozzles beyond question. This is one of the refinements of blast furnacing, and the development of the gauge reflects much credit on the makers. It has been introduced at a number of places, giving much satisfaction."

At the instance, also, of Mr. Janney, attention was called to the recent discussion of the Effect of Saccharine Matter on Mortars.

Prof. L. M. Haupt noted the Increased Weight of Locomotive Engines, as Affecting the Strains on Railway Bridges, instancing the dimensions of an engine recently constructed at the Baldwin Locomotive Works, which weighs 148,000 lbs., 134,000 lbs. being carried on the 10 driving-wheels. The greatest weight on one pair of drivers is 27,000 lbs. The tender weighs 82,000 lbs., and the live load of the engine and tender is 3,940 lbs. per foot.

Prof. Haupt also referred to two recent legislative matters of interest to engineers; the Wheeler bill for the examination of the earth's crust, and progress in the matter of rapid transit for Philadelphia.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, on the evening of February 2, President Worthen in the chair.

Mr. Dorsey's paper on Irrigation was further discussed. Mr. George G. Anderson, Chief Engineer of the Northern Colorado Irrigation Company sent a written discussion, in which he dwelt on the necessity of storage reservoirs. The present duty in Colorado was 56 acres per cubic foot per second. The usual allowance of 50 per cent. for loss by evaporation and seepage was excessive with the best construction.

Mr. E. E. R. Tratman submitted some notes on Irrigation in Spain, and Mr. A. D. Foote noted a recent Arizona decision that owners of irrigation lands have inalienable rights to water supply, though they have no ownership in the ditch.

The Secretary read a paper by Prof. J. A. L. Waddell on Specifications for strength of Iron Bridges. The paper referred to the practice of working out strains to a fine point, the precise basis for which was little better than guess work. He thought a few empirical rules would be simpler and more practicable. He also referred to the question of uniform specifications and thought that, while a general specification might be made to cover ordinary work, special specifications should be drawn up for extraordinary work, such as cantilevers, long spans and braced piers.

This paper was discussed by Mr. Macdonald, who said that at a recent conference the manufacturers were able to agree on standard specifications, but the engineers would not give up their individual ideas. He did not think a uniform system of specifications possible or advisable.

Mr. Cooper thought that the manufacturers were not proper parties to prepare standard specifications.

President Worthen gave some reminiscences of the manner in which some of the old Howe-truss bridges on the Boston & Albany were widened for double track.

In response to a suggestion from the President, it was decided that all regular meetings should be called to order at 20.15 o'clock hereafter. The Society then adjourned.

The following have been elected members: David A. Maxwell, St. Stephen, N. B.; Silvanus Miller, Jr., Hatfield, Mass.; George S. Morrill, Boston; George F. Simpson, John Thompson, New York. Juniors: George H. Leland, Providence, R. I.; John M. Stewart, Dobbs Ferry, N. Y.; Arthur S. Tuttle, Brooklyn, N. Y.; Schuyler S. Wheeler, New York.

At the regular meeting on the evening of February 16, the death of Mr. W. W. Wilson, a member of the Society, was announced, and the usual committee to prepare a memorial was appointed.

Mr. Wm. H. Grant then read a paper on Calculation of the Mean Horse Power of a Variable Stream and the Cost of Replacing Power Lost by a Partial Diversion of the Flow. This paper was based on investigations made to determine damages due to a number of persons on account of the partial diversion of the flow of the Bronx River as a water supply for New York City; also to determine the cost of replacing the lost water-power by steam-power.

The paper was discussed by Messrs. Worthen, Emery, North and Davis. The discussion was, however, somewhat limited by the fact that some of the cases are still before the courts to determine the legal questions involved.

The Secretary exhibited some fine specimens of *teredo navalis* sent from Pensacola by Mr. Thorne.

Engineers' Club of St. Louis.

THE regular meeting of this Club was held at Washington University, St. Louis, on the evening of February 2, Vice-President Holman in the chair; 23 members and 7 visitors present.

A number of applications for membership were received and referred. Messrs. Arthur J. Firth, Charles H. Ledlie and Edward K. Woodward were elected members. Mr. R. S. Hays resigned on account of removal from the city.

Mr. J. A. Seddon then read a paper on Efficiency of Cable Roads; its Variation with Length of Cable and other Elements of the Construction. Mr. Seddon called attention to the lack of reliable data on the subject, and the difficulty of ascertaining results reached by roads now in operation The paper gave a thorough analytical and practical discussion of the subject and was of decided value. Mr. Seddon gave some results of recent tests on the St. Louis Cable road, but stated that the trials were not yet complete. The paper was discussed by Messrs. Johnson, Nipher, Adams, Bruner and Bryan.

It was voted that Dr. Adams' paper on Dynamo Electric Machinery be made the special order for the meeting of February 16.

Professor Nipher exhibited a piece of apparatus he had devised for determining losses in the magnetic fields of dynamos.

The Club then adjourned.

This Club met in St. Louis, February 16, President Potter in the chair; 18 members and 3 visitors present. Messrs. H. B. Gale, Otto Schmitz and Arthur Thacher were elected members. Several applications for membership were announced and referred.

The Secretary read a letter from Mary G. Smith acknowledging the receipt of the Club's testimonial to the late C. Shaler Smith.

The Secretary also read a communication from Jno. W. Weston, Commissioner-General for the United States for the Paris Railway Exposition and Jubilee, on the desirability of the Club being represented in some way. The matter was referred to the Executive Committee.

Dr. Wellington Adams then read a paper on Design and Construction of Dynamo Electric Machinery, which was illustrated by diagrams and electrical apparatus. The subject was handled in a thorough manner, and a number of formulæ were given showing how the efficiency of any dynamo could be calculated. It was shown that these formulæ held the same relation to the dynamo machine that the indicator card does to the steam engine. The paper was discussed by Messrs. Gale, Nipher and Seddon.

The President announced the subject for the paper for the next meeting to be Present Aspect of the Problem of the Inter-Oceanic Ship Transfer, by Robert Moore. The Club then adjourned.

Illinois Society of Engineers and Surveyors.

THE Illinois Society of Engineers and Surveyors held its second annual meeting at the State University at Urbana, Ill., beginning January 26th, with a large attendance.

Vice-President T. J. Burrill delivered the address of welcome in behalf of the University, and responded to by C. G. Elliott, Chairman of the Executive Board, on behalf of the Society. Next came the address of the President, Professor I. O. Baker, of the civil engineering department of the University. The address was confined to a short review of the advances made in the different departments of civil engineering throughout the civilized world, but more particularly in the United States, during the past year. It was highly interesting and closely listened to by his audience.

After the President's address reports of committees were heard and the following elected members: John R. Lewis, Piper City; Samuel S. Greely, Chicago; Daniel W. Mead, Rockford; Fletcher H. Chapman, Carlinville; Thomas S. McClahan, Monmouth; George V. Loring, City Engineer, Decatur; Jacob J. Foster, County Surveyor of Cook County, Chicago; Frank V. Alkire, Petersburg.

At the evening session the first report was that of the Committee on Sanitary Engineering and Water Supply, by Professor A. A. Talbot, Champaign. The different kinds of systems of water works was discussed at length, and the faulty construction of stand-pipes exposed.

S. A. Bullard, City Engineer of Springfield, read a paper on Combined *versus* Separate System of Sewerage for Small Cities. The combined system is that in which one system of pipes is used, while the separate system is that in which two systems of pipes are used—one to carry off storm, surface and cellar water, and another to carry off refuse from dwellings. The benefits and advantages of both systems were discussed at some length. In regard to sewer ventilation it was found that in some cities in the State, street openings were found the best, while in others manholes were the most satisfactory.

Samuel S. Greely, of Chicago, read an interesting paper on the License System for Surveyors. He contended that as the law is now the private surveyor had the advantage of the county surveyor, because he has the same advantages and not the drawbacks of the latter. He argued that the State should license engineers and surveyors, the same as physicians and lawyers. In the discussion that followed, it was agreed that surveyors and civil engineers should be entitled to the fees of experts when compelled to attend court.

On the second day a number of papers of much interest were read. Prof. D. O. Baker, of the University of Illinois, delivered an illustrated lecture on Bridges. Prof. Theo. B. Comstock, a paper on Natural Gas and Oil in Illinois, which elicited great interest, and much information on that subject was gathered from various members in the discussion which followed.

Other papers read were: Pavements for Small Cities, by George F. Wightman, City Engineer, Peoria; Water Supply for Small Cities, by K. R. Croswell, City Engineer, Kankakee; Railroad Trestles, by E. A. Hill, Chief Engineer, Indianapolis, Decatur & Springfield Railroad.

The following officers were chosen: President, I. O. Baker, Champaign; Vice-President, J. T. Foster, Chicago; Executive Secretary, A. N. Talbot, Champaign; Recording Secretary, S. A. Bullard, Springfield; Treasurer, G. P. Ela, Bloomington.

The Society adjourned in the evening, after a very successful meeting.

The Master Car-Builders' Club.

A MEETING of the Club was held in the rooms, 113 Liberty Street, New York, on February 17. Mr. C. E. Garey called the meeting to order. Action on the change of name and organization was postponed. The subject on discussion was the lighting and heating of cars. Mr. Baker was called on and said his heater had warmed a million of people. He claimed to have been the first one who suspended a stove below the car. His company was engaged in perfecting a heater which should be protected in case of collision. He said he had offered Mr. Depew to equip a train of cars with safety heaters and then have a collision. In case the heaters set fire to the car their company would pay the costs.

Mr. Creamer said that the newspapers insisted that cars should be heated from the engine. He thought that a stove or heater could be made safe. He inquired whether all the other elements of safety were attended to. Were the baggage-car stoves safe? He thought that the fires generally originated in the baggage, mail and express cars. If steam heat is used he would place a coil of pipe at the end of the car, and introduce a current of air over the pipes and warm the air.

Mr. Smith, of Dunkirk, N. Y., representing the Martin Heater, said all stoves in cars are dangerous. If the fire was inclosed in a Krupp gun the fire would be heard from in case of collision. He advocated the removal of the stoves from the cars. He represented a company which had trains on the Boston & Albany and a number of other roads, some of which had been in service for three years. The system takes steam from the locomotive, and the pressure is reduced.

Mr. Emerson spoke in favor of his system of heating.

Mr. Hopkins said that the use of steam prevented entirely the danger from fires and this part was very important.

Mr. Gold, of New York, said his system was in use in 900 cars on various roads. He described his system, which consists of a receptacle for water, which is heated by a steam-pipe which passes through the water. By this means the heat is stored in the water. Mr. Bernstein, who represented Mr. Cline, exhibited a heater in which he used a fuel that he said would not set fire to anything. A member put some of the burning fuel in a newspaper which was set on fire by a gentle breeze.

Mr. Owens exhibited one of his heaters, which is made of boiler-plate, with a coil of pipe inside. Several other methods of heating were described, but nothing new or important was exhibited.

New England Railroad Club.

THE regular monthly meeting of this Club was held at its rooms in the Boston & Albany passenger station in Boston on the evening of Wednesday, Feb. 9. President J. W. Marden occupied the chair, and there was a large attendance, about 160 persons being present, including many prominent railroad officers.

After the meeting had been called to order a committee was appointed to nominate officers to be voted for at the annual meeting in March.

The regular order—the Heating and Lighting of Cars in Passenger Service—was then taken up.

Mr. A. A. Folsom (Boston & Providence) asked for particulars in relation to a recent accident on the Fitchburg road

President Marden (Fitchburg) gave an account of the accident referred to, in which two passenger cars and a sleeping car were overturned, but the heaters in the cars were not injured and the cars did not take fire.

Mr. J. N. Lauder (Old Colony) said that, in view of the recent terrible accident in Vermont, the railroad members of the Club, at least, ought to approach the subject of heating cars with the greatest care, and be prepared to throw over their preconceived notions if necessary. He was still of the opinion that cars have, for years to come, got to be heated individually, and the question is how to do it safely. He was free to admit that trains can be heated by a continuous system from the engine, but there are many difficulties in the way of its general adoption for all roads and all trains. He thought that the hot-water heating system is the only one yet proved to be a success, and one way of making it safe is to enclose the heater in a steel box, which will

not let the fire out into the car in case of derailment. The cost, he believed, would not stand in the way of its adoption by any railroad.

President Marden said that public opinion, as expressed in the newspapers and elsewhere, was evidently in favor of some system of heating by means of steam from the locomotive, and he would like to hear from gentlemen present some opinions on this question.

Mr. F. D. Adams (Boston & Albany) said that he was still a believer that steam heat is the coming heat. It is true there are some difficulties, but he thought they were not insurmountable. He believed the officers of his road were satisfied they have got to heat their cars with steam from the locomotive for both safety and economy. The success of the Martin heater has been such that they had no general fault to find, and he thought that before the winter had gone another train will be equipped. The train now equipped has not lost a trip, and that cannot be said of some other heaters, for they are frequently in the shop for repairs of the pipes. Steam heating is being put in almost all buildings, and the stations at all points can easily be equipped with steam-heating apparatus and a pipe be run from it to heat cars before being attached to the engine. Mr. Adams told about the success in warming the cars in the coldest weather of the past month He said Mr. Lauder's plan was feasible, but he did not approve it because he thought steam is the coming heat. He thought that five years hence a good many trains, in New England at least, will be heated with steam, and the time is coming when it will be as universal as the Westinghouse brake.

Mr. Robert Miller (Michigan Central) said he thought that steam-heat apparatus would have to be put in at terminal stations to heat the cars before they started out. In case the train was snow-bound and the engine fire gone out he thought a supplementary heater in the cars would have to be provided. He thought, perhaps, there is as much danger from lighting as from heating, and both should be guarded against.

Mr. J. T. Woodward (Portland, Me.) was invited to explain the Sewell heater, a system of steam heating from the locomotive now on trial on the Maine Central road. He said that a car of the present style is really as perfect a man-trap, in case of collision, as could well be devised. The passengers sit with their feet under the seats, which slide together in case of collision, pinning them down; and, the heaters breaking, let their fire out among the upholstery, which is thoroughly dried and prepared for rapid combustion. He then described the Sewell system in general terms.

Mr. Sewell, the inventor of the heater, followed by describing its mechanical construction. Steam is taken from the engine, both exhaust and direct, through a peculiar patent coupling in the center of the car. The piping is along the side of the car instead of having convolutions of pipes under the seats. In the aisle of the car is a simple valve for turning on the heat. Steam is taken at a very low pressure, and the cars are kept at a temperature of 70° or more. A hot-water well under the car is provided for superfluous water, and a provision is made for heating it by a grate beneath. [Mr. Sewell here exhibited his patent coupling, used to connect the pipes in different cars.] Cars equipped with the Sewell heater would not couple with the Martin system, but if the same coupling was used, which could readily be done, the two systems could be run together. Mr. Sewell stated that the heater had been in operation since 1880, though he had been at work perfecting it from that time to the present. The pipes used are 1¼ or 1½ inch, three of them on each side of the car.

Mr. R. H. Blackall (Delaware & Hudson Canal Company) said that he could not say what difficulties would stand in the way of taking steam from the locomotive on his road.

Mr. G. H. Griggs (Providence & Worcester) said that he could see no objections to heating his cars with steam from the engine, though if his road connected with other roads he should want to know if the other road was to put it on before he did.

Mr. Robert Johnson (inventor of the Johnson heater) read recommendations showing that his heater furnishes abundant heat in the coldest weather. He said that, as regards safety, his heaters have been in several accidents and the fire has been immediately extinguished.

Mr. R. B. Owen (Detroit, Mich.) explained the manner in which the Smith & Owen Heater Company guards its heaters from all danger of setting the cars on fire. The heater consists of a steel boiler made of plates ¼ inch thick, and surrounded by a water-space 1¼ inch wide; the boiler is bolted firmly to the floor; the doors to the fire-box and the ash-box are protected by a sliding steel sheet, securely fastened. The steel boiler is as strong as any locomotive boiler, and would not be broken by collision.

Mr. Adams said it was evident from what had been presented that steam heating is practicable, and he was more firmly convinced than he ever was before that steam is the coming heat.

Mr. Edward E. Gold (New York) described his system of steam heating, which is in use on the elevated railroads in New York. He said his system is substantially the same as those described by others, except in the method of storing the heat. He uses two pipes, one within the other; the outer one is 4 inches in diameter and the inner 3½ inches. The inner pipe is filled with hot water, which is heated by the steam at the same time the car is heated. The car can be kept heated from five to seven hours after being detached.

Mr. J. N. Lauder said that any system of steam heating, to be adapted to the use of the railroads running into Boston, must be capable of warming at least 12 cars.

Mr. Waterman Stone (Providence, Warren & Bristol) said that they had just equipped a train with the Gold system, having decided on that system because of its capacity for storing heat. He promised to tell the Club at its next meeting how that system had worked.

Mr. Peck explained a casing of boiler iron which had been invented to put over any heater in a car, and which works automatically. He also exhibited a model of the invention.

Mr. Baker (inventor of the well-known Baker heater) described his heater and claimed that the system of heating with steam from the engine is only suitable for short roads or runs.

On account of the length of the discussion on the heating question, the second branch of the subject—Lighting—was postponed until the March meeting, and the Club adjourned.

The next regular meeting, which will be held at the usual place on Wednesday, March 9, will be the annual meeting, at which the reports of officers will be presented, and officers will be elected for the ensuing year. After this routine business has been transacted, the subject of Lighting Passenger Cars will be discussed.

The Master Car-Builders' Brake Committee.

A MEETING of the M. C. B. Committee on Freight Train Brakes was held at the Hotel Anderson in Pittsburgh, February 9. The meeting, as previously announced, was held to determine the rules and conditions governing the brake tests to be held at Burlington, Ia., prior to the Master Car-Builders' convention in June next.

The Committee first held a private meeting, after which a joint meeting was held of the members of the Committee and the representives of the brake companies. At the joint meeting the rules prepared by the Committee were submitted, fully discussed and finally agreed upon.

There were present at the meeting Messrs. G. W. Rhodes, Chairman, J. S. Lentz and D. H. Neale, of the Committee, and the following representives of the different brake companies that propose taking part in the tests: American Brake, Geo. H. Poor; Carpenter Air Brake and Carpenter Electric Brake, Thomas Prosser, Jr.; Eames Vacuum Brake, Jas. H. Slade and N. W. Howson; Hanscom Automatic Air Brake, W. W. Hanscom; Park Electric Brake, H. S. Park and W. Sherman; Rote Brake, C. F. Harding; Waldumer Electric Brake, L. W. Goss; Westinghouse Brake, T. W. Welsh, S. H. Sprague, Levi W. Close and F. Moore; Widdifield & Button Brake, W. D. Widdifield; Ward Brake, W. H. Ward. Mr. F. S. Wood acted as Secretary.

It was decided that the tests at Burlington should begin on May 9, instead of in April. The tests to be made are as follows:

TESTS.

1. Fifty empty-car trains making 4 emergency stops; first, 20 miles per hour on a level; second, 40 miles per hour on a level; third, 20 miles per hour on 53-foot grade; fourth, 40 miles per hour on same grade.

2. Fifty mixed-car trains, two-thirds of the cars loaded, one-third empty, 75 per cent. of the latter being in front half train; first, second and third stops as above, fourth stop on grade at 30 miles per hour.

3. Fifty mixed-car trains with hand brakes and engine and tender automatic brakes; four emergency stops; first, on a level at 20 miles per hour; second, at 30 miles per hour on a level; third, at 20 miles per hour on 53-foot grade; and fourth, at 30 miles per hour on same grade.

4. Train of 50 mixed cars to be let down a 53-foot grade 3 miles long; speed 20 miles per hour at top of grade to be reduced to 15 miles per hour as soon as practicable and maintained without material variation to the foot of the grade.

5. One or more runs over the course to be made with trains having brake shoes ½ to ¾ in. off the wheels before the brakes are applied.

6. Fifty mixed-car trains; tests on the level; trains to be broken into two or more unequal parts, speed 30 and 20 miles per hour; after the train is broken any assistance will be ren-

dered only by a brakeman, who shall be riding at the rear of the train or on the engine when the breakaway occurs.

7. Train resistance test; fifty-car mixed trains, first to pass No. 1 stop post at 20 miles per hour, letting the train drift to a stop, no brakes being applied; second, to pass No. 3 post at 5 miles per hour, letting train drift until No. 4 post is passed, at which point the accelerated speed shall be recorded and the train stopped.

THE RULES.

The rules as adopted are given below:

1. Each brake company will provide its own engine; such as do not wish to furnish a special crew will be furnished from working crews of Chicago, Burlington & Quincy Railroad. Ordinary eight-wheel, four wheels coupled engines must be employed; each engine must have 17 X 24 inch cylinders and not less than 51,000 lbs. on the drivers; both tender trucks must be provided with brakes and cast-iron shoes; plain wrought-iron shoes to be used on the drivers. Each brake company to have the option of using its own or such other engine brake as it can procure.

2. Each brake company will furnish, fitted with its brake, 50 box cars of 40,000 lbs. capacity or over, and 34 feet long being preferred. Each car to be equipped with brakes on both trucks and plain cast-iron shoes. The cars to be delivered to the Committee, free of charge, at some point on the Chicago, Burlington & Quincy Railroad on or before May 2. After the trial the cars will be returned to the owners at the points of delivery.

3. The Chicago, Burlington & Quincy Railroad will not be held responsible for mileage of cars while on its lines or for any damage to the cars that may occur through the inefficiency of the brakes.

4. Close couplings are recommended, and companies using link and pin couplers must be provided with wedges to take up slack. Half the stops will be made with close couplings and half with slack, should any of the brake companies so elect.

5. In operating brakes they must be applied and released by the engineman only, except as specially provided for in test No. 6, special tests.

6. Three runs over the course will be made with tests one, two and four. Two runs will be made with test number six, and one run with tests numbers three, five and seven.

7. Sand must not be used on any of the stops except with the special permission of the Committee.

8. The leverage of the brakes will be recorded by the Committee, and none of the apparatus must be changed at any time during the trials, except as previously provided.

9. With continuous brakes the pressures carried on the engine prior to the application of the brakes will be recorded for each test.

10. All tests to be made under like conditions of rail, grade, etc., as near as possible.

11. A dynamometer car will be placed in the front end of each train with complete recording mechanism. In the middle box-car of each train a portable apparatus will be placed for recording diagrams, showing, first, a strain line in pounds exerted on the brake lever during the stops; and, second, a speed line in miles per hour during each stop. An electrical signal will be arranged for communication between the front and rear ends of the train.

12. Competitors will be subjected to all the general tests; special tests will be optional.

13. The rapidity with which the train gets away after a stop will be noted, the time being taken from stop to start. In case breakages or causes foreign to the brake interfere with getting away, the record will be thrown out.

14. The parts pertaining to each brake, other than the foundation brake, hose and diaphragms, will be painted a red-lead color.

15. Each brake company will use its appliances in the manner it shall consider best, provided that in the opinion of the Committee such methods are safe and practicable in ordinary working.

16. The Committee reserves the privilege of adding such tests as in its judgment may be deemed desirable.

17. Three or more competitors will be required before the tests will be entered into. Any competitor desiring to enter the tests should communicate with the Chairman on or before April 1.

18. The Committee are not in a position to furnish equipment for these tests, but regards the subject of great interest to railroads and trust they will contribute to its success by furnishing engines and cars to the competing brake companies and affording them any other reasonable facilities.

The shocks during the stops will be measured by the movement of the "slidometer," a 16 lbs. turned iron weight free to slide in a planed pine trough placed horizontally in the way car at the rear of the train. A movement of more than 12 inches will be considered objectionable, as indicating a shock violent enough to injure stock.

Tests 6 and 7, which relate to trains breaking away and the frictional resistance of the cars, are special tests, and are therefore optional.

National Electric Light Association.

The annual meeting of this Association began in Philadelphia, February 15, with about 100 members present.

The meeting was called to order by President J. Frank Morrison, who made an address reviewing the work done in electric lighting during the past year. Brief addresses were made by Mr. Thomas Dolan and Col. A. Loudon Snowden.

After routine business had been disposed of, the Committee on Standard Gauge reported, through A. V. Garratt, of Boston, in favor of rejecting the British standard and establishing a new gauge to be called the National Electric Gauge. Mr. C. C. Haskins, of Chicago, then read a paper on High Insulation. At the evening session Prof. E. R. Weeks, of Kansas City, read a paper on Popular Prejudice Against Electric Light Wires, and a commission of five, consisting of Prof. Houston, M. M. Garver, Prof. Marx, Reuben T. Robinson and C. Herring, was appointed to investigate the best system of insulation for electric-light wires.

On the second day, Mr. Stuart, of the Legal Committee, presented a paper on Irregularities in Decisions of the Patent Office, accompanying it with a bill which he urged should be presented to the next session of Congress. It was called for by the want of uniformity in the decisions which emanate from time to time from the respective Commissioners of Patents, and which ought to be corrected. The bill provides for a Commission of three, to be appointed by the President of the United States, which Commission shall examine the present patent, trademark and copyright laws of the United States and those of other countries, and shall formulate a report to be presented to Congress setting forth the results of the investigation and the conclusions of the Commission, together with an act providing for such changes as may be found necessary.

Later on in the session a resolution was adopted referring the matter to a committee of five to present the bill to Congress.

J. H. Shay, of Chicago, presented a paper on Transmission of Power by Belting, in which he stated that for electric-light machinery it was desirable to use evenly-matched belting of uniform thickness.

The subject of Electric Motors was discussed in a paper read by W. H. Baxter, Jr., of Baltimore. This paper was discussed at length by F. J. Sprague, of New York, and Prof. Houston, of Philadelphia.

A communication from the Electric Club of New York was read, urging the appointment of a committee by the National Association to coöperate with a similar committee from the Club in considering the question of uniform rules and regulations for governing the installation of electric-light plants. The latter was referred to the Committee on Insulation.

A. F. Upton, of Boston, presented a paper on Plans for Electric Light and Power Stations, in which he gave practical hints on equipment and the furnishing of plants, dwelling particularly upon the necessity of considering the possibilities of growth.

A. J. De Camp, of Philadelphia, Chairman of the Executive Committee, offered a resolution providing for the appointment of a committee of five to tabulate rates for motor service, based upon rates for arc and incandescent-light service, from stations developing over 300 horse-power.

In the evening the Association visited, on invitation, the Franklin Institute, where a number of subjects were discussed of general scientific interest. The visitors were welcomed in a speech by Mr. Joseph M. Wilson, President of the Institute, to which a response was made by President Morrison.

At the close of the session a number of the visitors accepted the invitation of the Keystone Light & Power Company to visit its station on Sansom Street.

On the third day, Mr. F. H. Ball, of Erie, Pa., read a paper on the Direct Transformation of the Heat Energy of Coal into Electrical Energy.

This was followed by a paper on the Electrical Motor, as applied to the Propulsion of Street Cars, by Mr. Charles J. Van Depoele, of Chicago. In this paper reference was made to the advance made in this direction, and an account was given of the work done by the electric motor in Minneapolis.

Mr. Joseph Wetzler, of the *Electric World*, spoke of Incandescent Lighting from High Potential Circuits. He referred to

the demand for incandescent service to be supplied from stations, and the obstacles which had been met in introducing such service. The object aimed at was to reduce the quantity of copper required for the distribution of the current to incandescent lamps. This could be accomplished by increasing the electro-motive force employed on the circuit and reducing correspondingly the total current required. To accomplish this he suggested the use of storage batteries.

Dr. Otto A. Moses, of New York, treated the subject of the Distribution of Electrical Energy by Means of Secondary Generators. He argued that, by the use of secondary generators, currents of 20,000 or 30,000 volts could be as readily and safely generated and distributed as those of the present limit of 500 or 700 volts. He predicted that by this means the vast power of Niagara Falls could be utilized and even transmitted to New York in the near future. He spoke at length of the secondary generators now in use in the incandescent system in Pittsburgh.

Mr. I. Fugioka, a Japanese engineer, then made an address, in which he described the electric-lighting system of Tokio, Japan. The Tokio Electric Light Company, organized a year ago, supplies 2,000 incandescent lamps and about 100 arc lights from its plant, located in the suburbs of Tokio. The system embraces the residences of the upper classes, and also furnishes light to the new palace. Mr. Fugioka gave some interesting information concerning the rapid progress of electrical science in Japan and the extensive use of the telegraph and telephone.

Mr. S. Yoshima, President of the Tokio Electric Light Company, was also present, and both gentlemen were elected honorary members of the association.

The election of officers resulted as follows:

President, J. F. Morrison, Baltimore. First Vice-President, E. R. Weeks, Kansas City. Second Vice-President, A. J. De Camp, Philadelphia. Treasurer, Charles Cooper, Brooklyn. Secretary, Thomas McCoubray, Baltimore. Executive Committee, F. A. Gilbert, Boston, Chairman; George S. Bowen, Elgin, Ill.; Frank Ridlon, Boston; Stephen Holbrook, Philadelphia; Dr. Otto Moses, New York; Eugene T. Lynch, New York; J. F. Noonan, Paterson, N. J.

The Association adjourned to meet in Boston in August. Most of the members left for New York during the afternoon to attend a dinner of the Electric Club and listen to a paper by Mr. Stephen D. Field on Electric Motors.

American Institute of Mining Engineers.

THE forty-seventh meeting of the Institute began at Scranton, Pa., on the evening of Tuesday, February 15. Vice-President James D. Weeks called the meeting to order.

The Secretary, Dr. R. W. Raymond, then read a letter of regret from President Richards, who is now in Bermuda on account of his health. This was followed by Dr. Raymond reading a biographical sketch of the late Mr. Martin Coryell, who recently died at Lambertville, Pa., and who was one of the founders and the first Secretary of the Institute. Dr. Persifor Frazer then made some remarks on the progress which had been made in the work of the International Geological Congress at the last session in Berlin, and made an earnest appeal to the members of the Institute to look more thoroughly into the matter, and see that at the next session of the Congress, to be held in London in 1888, America be well represented. Dr. T. Sterry Hunt then spoke a few words indorsing the remarks of Dr. Frazer.

The meeting was then adjourned so that the members could attend the handsome reception prepared for them by the citizens of Scranton. The members were all taken in charge by the local committee, and introduced to the ladies and gentlemen of Scranton. The evening was passed in pleasant social intercourse, and was closed by a handsome collation.

Wednesday was devoted to a visit to the extensive works of the Lackawanna Coal & Iron Company and a drive through the City of Scranton. In the evening a business session was held.

On Thursday morning the members visited the Pine Brook coal-breaker, and also the large shops of the Dickson Manufacturing Company. Business sessions were held in the afternoon and evening.

On Friday there was an excursion over the Delaware, Lackawanna & Western road and a visit to several coal mines. A business session at 4 P. M. and the annual dinner in the evening closed a very successful meeting.

The following papers were presented at this meeting, several of them being discussed at much length:

The Animikie Rocks and their Vein Phenomena, as shown at the Duncan Mine, Lake Superior; by W. M. Courtis, Detroit, Mich.

Concentration and Smelting at Tombstone, Arizona; by John A. Church, Tarrytown, N. Y.

Experiments in Matting Sulphides; by E. Gybbon Spilsbury, New York City.

Magnesium Carbonate as a Non-Conductor of heat; by E. Luttgen, Ambler, Pa.

Notes on the Saving of Sulphur and Ammonia from Gas; by W. H. Adams, New York City.

Rail-Sections; by W. F. Mattes, Scranton, Pa.

The Bessemer Department of Jones & Laughlins, Limited; by P. Barnes, Pittsburgh, Pa.

General Account of the Iron Ores used in the Chattanooga District; by H. S. Fleming, Dayton, Tenn.

Comparison of some Southern Cokes and Iron Ores, by A. S. McGreath, Harrisburg, Pa., and E. V. D'Invilliers, Philadelphia.

Apparatus for Volumetric Determinations with Potassic Permanganate; by Clemens Jones, Hokendauqua, Pa.

The Microscopic Structure of Steel Rails; by F. Lynwood Garrison, Philadelphia.

Distribution and Proportions of American Blast-Furnaces; by John Birkinbine, Philadelphia (carried over from the St. Louis Meeting).

Geology and Mining of the Northern Anthracite Coal Field of Pennsylvania; by Frank A. Hill, Philadelphia.

A Water-cooled Producer; by W. J. Taylor, Chester, N. Y.

Western Railway Club.

THE regular meeting was held in Chicago, February 16, President Scott in the chair. There was a large attendance.

Mr. G. W. Rhodes made an announcement of the brake tests at Burlington, giving the rules for the trials, which will be found elsewhere.

The subject of Car Heating was then introduced by Mr. Allen Cooke, who referred to the public demand for some substitute for stoves. Letters from several parties were read.

Mr. Barr (Chicago, Milwaukee & St. Paul) said that they were trying the Martin and the Westinghouse systems of steam heating, but were not yet prepared to report results.

Mr. Martin (Martin Anti-fire Car Heating Company), by request, described his system at considerable length, answering many questions from members.

Mr. Rhodes said that when electric lighting was introduced the impression was that gas would be dispensed with. In practice both are used, one to help the other. Something similar will probably happen with car heating. Fire in the locomotive rarely causes fire in wrecks, because it is properly protected. Stoves could be made equally safe.

The discussion was further continued by Messrs. Mead, Townsend, Barr, Martin, Schlacks, Quayle, Forsyth, Kirby and Pullman.

Mr. Sinclair said that there was no danger from the explosion of steam pipes in the cars, the steam having too low a pressure.

Mr. Kirby said that the Lake Shore road would apply the Martin system to a suburban train for trial. It was also stated that the Rock Island road would try the Westinghouse heater.

The Interchange Rules were then taken up. Rules 17, 18 and 19 were approved. Rule 15, it was voted, should be amended by substituting the words "kind and quality of material" for "kind of material." Amendments to Rules 16 and 20 were also suggested.

It was decided to continue the subject of Car Heating at the March meeting; to be opened by Mr. William Forsyth. The balance of the Interchange Rules will also be discussed, the subject to be opened by Mr. Mead.

Steel Rail Prices in Europe.—A contract for 13,000 tons of steel rails for a new line in Portugal was recently let to the Bochum Steel Works in Germany at 112 francs ($21.75) per ton. Bids were received from Krupp at 113 francs and the Cockerill Company at Seraing, Belgium, at 116 francs.

An order for 21,000 tons of steel rails for Italy has been divided, the Ebbw Vale Company (England) taking part at 112 francs, Bolckow, Vaughan & Co., England, part at 120, and the Cockerill Company, Belgium, the rest at 120 francs.

The Council of Public Works of Italy has recommended that the bid of the Terni Steel Works be accepted for the supply of 150,000 tons of steel rails for new branch lines. Delivery is to extend over four years, the price to be 169 lire ($32.75) per ton loaded on cars at the works.

PERSONALS.

Mr. D.W. C. Perry is Chief Engineer of the Parsons & Pacific, a new Kansas road.

Mr. T. Marino is now Assistant Engineer of the new Augusta & Chattanooga road in Georgia.

Mr. A. J. Vosburgh is Chief Engineer of the Ripley & Mill Creek Valley, a new West Virginia railroad.

Captain Henry M. Adams has been promoted to be Major, Corps of Engineers, in place of Suter, promoted.

Mr. William Cappeller has been appointed Railroad Commissioner of Ohio, to succeed Mr. H. C. Apthorp.

Mr. Thomas Downing has resigned his position as Master Mechanic of the St. Paul, Minneapolis & Manitoba road.

Passed Assistant Engineer Frank H. Bailey, U. S. N., has been assigned to duty at Cornell University, Ithaca, N. Y.

Mr. R. H. Temple has been appointed Chief Engineer of the new Tennessee Midland Railroad, with office in Memphis, Tenn.

First Lieutenant William M. Black has been promoted to be Captain, Corps of Engineers, in place of Adams, promoted.

Mr. H. W. Hamilton has been appointed Superintendent of Construction of the Minneapolis, Sault Ste. Marie & Atlantic road.

Mr. E. P. Moulton has resigned his position as Master Mechanic of the Vermont Division of the Boston & Lowell Railroad.

Mr. J. R. Hoffman, Engineer of the Carthage & Adirondack Railroad, has resigned his position and has gone to Colorado.

Second Lieutenant Hiram M. Chittenden has been promoted to be First Lieutenant, Corps of Engineers, in place of Black, promoted.

Naval Constructor Fernald has been ordered to San Francisco, where he will supervise the construction of the new cruiser *Charleston.*

Mr. William J. Cochran, Sr., has been appointed Master Moulder of Ordnance, and has been assigned to duty at the Washington Navy Yard.

Mr. T. H. Perry, Chief Engineer and Purchasing Agent of the Lake Erie & Western road, is continued in that position on the reorganization of the company.

Mr. George A. Ferguson, Master Mechanic of the White Mountains Division of the Boston & Lowell road, has been given charge of the Vermont Division also.

Mr. O. D. Richard has been appointed Engineer of the Lake Shore Division of the Lake Shore & Michigan Southern Railway, in place of L. C. Brewer, resigned.

Mr. William Rogers, for some years past General Superintendent of the Central Railroad of Georgia, has been appointed Assistant to the President of that company.

Mr. D. H. Blackham has resigned his position as Superintendent of the Susquehanna Division of the New York, Lake Erie & Western road, on account of continued ill health.

Mr. Ross Kells has been appointed Superintendent of Motive Power of the New York, Pennsylvania & Ohio divisions of the New York, Lake Erie & Western road, with office at Cleveland, O.

Mr. Nathan P. Hobart, of New York, has been appointed Chief Engineer of the Vincennes & New Albany, a new railroad in Indiana. His headquarters will be in New Albany, Ind., for the present.

Mr. W. H. Starr, late Roadmaster of the Eastern Division of the New York, Lake Erie & Western road, has been promoted to be Superintendent of the Rochester Division in place of G. W. Bartlett, transferred.

Mr. R. E. Hardaway, who has been Chief Engineer of the Americus, Preston & Lumpkin Railroad during its construction, has resigned that position. His address will be at Tuscaloosa, Ala., for the present.

Mr. William E. Good has resigned his position as Master Mechanic in charge of the Philadelphia & Reading shops at Reading, Pa. He will connect himself with a large manufacturing enterprise in Philadelphia.

Mr. W. T. Reed has been appointed Master Mechanic of the St. Paul, Minneapolis & Manitoba Railroad, with office in St. Paul, Minn., in place of Thomas Downing, resigned. Mr. Reed was recently on the Canadian Pacific.

Mr. George G. Crocker, of Boston, has been appointed a member of the Massachusetts Railroad Commission in place of Thomas H. Russell, deceased. He is a lawyer, and, like Judge Russell, will be the legal member of the Board.

Mr. F. W. Sargent has been appointed Engineer of Tests of the Chicago, Burlington & Quincy Railroad in place of E. M. Herr, transferred to other duties. Mr. Sargent has been for some time employed in arranging the rail record of the road.

Mr. A. M. Tucker, for some time past Superintendent of the Western Division, New York, Pennsylvania & Ohio, has been transferred to the main line of the New York, Lake Erie & Western road, as Superintendent of the Susquehanna Division.

Mr. H. W. Reed, Roadmaster of the Savannah, Florida & Western, has been appointed Secretary of the Roadmasters' Association of America in place of Mr. D. H. Lovell, resigned on account of ill health. Mr. Reed's address is Waycross, Georgia.

Mr. George W. Bartlett, late Superintendent of the Rochester Division of the New York, Lake Erie & Western road, has been transferred to the company's leased New York, Pennsylvania & Ohio line as Superintendent of the Western Division.

Mr. Morris S. Belknap, formerly on the Louisville & Nashville, and more recently Superintendent of the Vicksburg & Meridian and the Vicksburg, Shreveport & Pacific roads, has been appointed General Superintendent of the Central Railroad of Georgia.

Mr. Herbert Hackney has been appointed Assistant Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad. He is a son of Mr. George Hackney, the Superintendent of Machinery, and has had charge of some important work, on the road and elsewhere.

Mr. William H. Stevenson has resigned his position as Superintendent of the New York Division of the New York, New Haven & Hartford road. He has been connected with that road for fifteen years. It is said that he will accept an important position on the New York & New England road.

Mr. George Hackney, Superintendent of Machinery and Car Department of the Atchison, Topeka & Santa Fé Railroad, has had his authority extended over the Atlantic & Pacific and the California Southern roads, which are controlled by the Atchison Company. Mr. Hackney's office will remain at Topeka, Kan.

Mr. George L. Fowler, Editor of the American Railway Publishing Company's paper (the *American Journal of Railway Appliances*, the *Street Railway Journal* and *Power*), has been appointed First Assistant Commissioner to the International Railway Exposition to be held in Paris during the coming summer. His address is No. 113 Liberty Street, New York.

Mr. E. M. Herr, for some time past Engineer of Tests of the Chicago, Burlington & Quincy Railroad, has been appointed Acting Superintendent of Telegraph, with office at Aurora, Ill. Mr. Herr has recently been giving much attention to telegraphic work, especially in connection with the application of the quadruplex system to the company's lines.

Mr. Henry Cope Whitehouse has succeeded in calling the attention of the Egyptian Ministry of Public Works to his project for restoring the ancient Lake Mœris as a storage reservoir in which a portion of the overflow of the Nile can be retained and used for irrigation in the dry season. Engineers are to make a careful examination and report on Mr. Whitehouse's plans.

Mr. R. R. Bridgers, Jr., has been appointed Engineer of Maintenance of Way of the Western North Carolina Division of the Richmond & Danville Railroad. Mr. Bridgers has been for some time on the Pennsylvania Railroad in the maintenance of way department ; he is a son of Hon. R. R. Bridgers, for many years President of the Wilmington & Weldon Railroad Company.

Mr. C. C. Wrenshall, Engineer of Maintenance of Way of the Northern Pacific, has resigned to accept the position of Superintendent of the Woodstock Iron & Steel Company, at Anniston, Ala. He will have charge of the building of that company's furnaces and steel works, and also of the location and construction of a railroad from Anniston to Gadsden, which the company intends to build. Mr. Wrenshall has been with the Northern Pacific since that line was completed.

Captain A. W. Greely, Fourth Cavalry, has been appointed Chief Signal Officer of the Army, with the rank of Brigadier-General, to succeed Gen. W. B. Hazen, deceased. Capt. Greely served through the war, having enlisted as a private in the 19th Massachusetts Regiment in 1861. After the war he received a commission in the Regular Army, and for 18 years

past he has been in the Signal Service, for several years being second in command. He is well known to the public from his service in the Signal Corps and from his connection with Arctic explorations.

Mr. John W. Cloud will succeed Mr. R. H. Soule as Superintendent of Motive Power of the New York, Lake Erie & Western road. Mr. Cloud has served in the motive power department of the Pennsylvania Railroad for a number of years; for six years past he has been Engineer of Tests, and on the death of Mr. J. B. Collin last year, he was appointed Mechanical Engineer also. Mr. Cloud joined the Master Car-Builders' Association in 1883, as representative member for the Pennsylvania Railroad, and has since taken a prominent part in its proceedings.

Mr. R. H. Soule has been appointed General Manager of the New York, Lake Erie & Western Railroad. The office is a new one on that road, and Mr. Soule will take part of the work heretofore performed by Vice-President Felton. Mr. Soule is still a young man, having been born in 1849. He graduated from Harvard College and entered the service of the Pennsylvania Railroad as a draftsman in the Altoona shops in 1875, receiving a position as assistant in the test department two years later. After two years of test and inspection work he was made Superintendent of Motive Power of the Northern Central road in 1879, and in 1881 was transferred to the Philadelphia & Erie. A year later, he was again transferred to the Pittsburgh, Cincinnati & St. Louis road, and in 1883 he resigned his position there to become Superintendent of Motive Power of the New York, West Shore & Buffalo road, where he remained until December, 1885, when he was made Superintendent of Motive Power of the New York, Lake Erie & Western, succeeding Mr. F. M. Wilder. On the Erie, Mr. Soule has been occupied in reorganizing the motive power department thoroughly, and it has doubtless been his efficient work there which has led to his promotion. Mr. Soule joined the Master Car-Builders' Association as a representative member, and has been prominent both in the conventions and in committee work.

Notes and News.

Cable Railroad in California.—The San Jose & Santa Clara Railroad Company has been organized to build a cable railroad 10 miles long from San Jose, Cal., to Santa Clara and Alum Rock.

New Steamer for the Allan Line.—Bids have been asked for in Glasgow for a new steel steamer of 5,000 tons for the Allan transatlantic line. The new steamer is to have triple-expansion engines.

American Machine Tools for France.—The Bridgeport (Conn.) Machine Tool Works recently shipped to France some machinery, which is said to be the first part of a very large order for tools for making fire-arms for the French Government.

Elevated Railroads in Cincinnati.—A bill has been presented to the Ohio Legislature providing for the organization of companies to build elevated railroads in Cincinnati. The routes proposed must be inspected and approved by the Railroad Commissioner.

The Hancock Inspirator.—The Hancock Inspirator Company celebrated the manufacture of the 100,000th inspirator by a dinner at the Quincy House, Boston, on the evening of February 21. A number of guests were present, and appropriate speeches were made.

Heavy Rails.—The Société Cockerill, at Seraing, Belgium, is rolling some rails of the Sandberg pattern, weighing 101 lbs. per yard. These will be the heaviest rails ever made, and are to be used at certain points on a line where trains are run at very high speed.

Shreveport Sewerage System.—A system of sewerage has been finally arranged for the City of Shreveport, La., and a contract for the work has been let to Samuel R. Bullock & Co., of New York. The pipes will be supplied by Blackmer & Post, of St. Louis.

Elevated Railroads in Chicago.—The Chicago Rapid Transit Company has taken steps to secure right of way for an elevated railroad through State and other streets. The project meets with much opposition, but the company promises to begin work early in the spring.

Hawkesbury River Bridge.—Work was actually begun on the foundations of this Australian bridge in October, and early in January one pier was down 15 feet in the solid, with 25 feet of concrete in it and 50 feet of the iron shell in place, and another caisson nearly ready for launching.

Railroads in the Italian Army.—The Engineer Corps of the Italian Army, under a new reorganization, is to include four companies of railroad men, experienced in the construction and operation of railroads, and one company of men competent to build and operate telegraph lines.

Improving the New York Canals.—Bills are before the New York Legislature providing for the improvement of the Erie and the Champlain canals. One bill provides for the expenditure of $500,000 for the purpose of lengthening locks near Syracuse, while another provides for more extensive works.

Price of Locomotives in England.—It is reported that the Lancashire & Yorkshire Railway has recently placed an order for thirty locomotives at £37 10s. a ton (equal to $180), which is said to be the lowest figure ever touched for that class of work. The Vulcan Foundry Company, Newton-le-Willows, is the contractor.

Cannon Making in Japan.—The German correspondent of *The Engineer* says: "According to news from Berlin, Krupp has lately made an arrangement with the Japanese Government to establish a branch of his cannon-making business in Japan, and is to manufacture all the heavy artillery the Government may require."

American Brake Company.—This company has been making additions to its works in St. Louis, including a new machine shop with a full equipment of tools. This has given the Superintendent, Mr. G. H. Poor, an opportunity to rearrange the works with a view to promoting economy and convenience in working.

Grade Crossings in Connecticut.—The Connecticut Railroad Commissioners, like their Massachusetts brethren, recognize the fact that highway grade crossings over railroads are a nuisance not to be tolerated in a thickly inhabited country, and in their report they strongly urge the passage of a law providing for their complete abolition.

Prince Edward Island Tunnel.—A company has been organized with $5,000,000 capital stock to build the proposed tunnel under Northumberland Straits, to connect Prince Edward Island with the mainland of New Brunswick. The company asks the Canadian Government to guarantee 4 per cent. interest on the cost of the work.

American Institute of Mining Engineers.—The officers chosen at the Scranton meeting to serve for the ensuing year are: President, Prof. Thomas Egleston, New York. Vice-Presidents, John Birkinbine, Philadelphia; J. F. Holloway, Cleveland, O.; E. S. Moffat, Scranton, Pa. Member of the Board of Managers for two years. C. Kirchhoff, Jr., New York.

Heavy Guns.—Commander G. W. Sumner, U. S. N., contributes a paper to the *Army and Navy Journal*, in which he argues very strongly against the efforts recently made to secure further experiments with cast-iron guns. He claims that such experiments would be merely a waste of time and money, in view of the experience already had with such guns in this and other countries.

Southern Coast Defenses.—A convention was held at De Funiak Springs, Fla., February 8, at which memorials were prepared for presentation to Congress, asking that steps may be taken to provide proper defenses for the Southern Atlantic and Gulf ports; also asking for the establishment of a manufacturing arsenal in the mineral region of Georgia, Alabama or Tennessee.

Steel Ties in England.—The Northeastern Railway Company (England) has recently placed with Bolckow, Vaughan & Co. an order for 2,000 tons (about 20,000 ties) of steel ties of the pattern adopted on the road. This, it is understood, is the first instalment of a very heavy contract. Bolckow, Vaughan & Co. have now at their works, at Eston, a special plate for making these ties.

Electricity, Effects of in Iron When Cooling.—Lieut. Zalinsky, the inventor of the dynamite gun and submarine torpedo boat, it is reported, on the authority of the *New York Herald*, has been making some preliminary tests which have shown that iron cooled while a strong current of electricity was passing through it was increased fully one-half in tensile strength and ductility.

Underground Telegraph Lines.—A London correspondent of *Science* says that during the controversy on overhead *versus* underground lines in England, the following statements have been put forward on authority: The English Post-office has 20,000 miles of underground lines, as against 22,000 in Germany. The cost of an underground wire is £350 per mile, and

of every additional wire, £15, as against £35 and £10 respectively for overhead wires. Underground wires diminish the speed of signaling from 25 to 75 per cent. over long distances. The cost of renewal and maintenance is about the same in both cases.

Close of an Old Mill.—The Fall River Iron Works, at Fall River, Mass., which were started in 1842, have been closed permanently. The mill made nails, hoop, band and bar iron, and its capacity was about 11,000 tons of finished iron yearly. The reason for closing is that the owners have found it impossible to compete with mills in Pennsylvania and other States close to the supplies of fuel and raw material.

Hardness of Metals.—In describing his instrument for determining the relative hardness of metals, by scratching with a weighted diamond—the harder the metal the heavier being the weight—Mr. T. Turner has remarked that the true hardness did not vary, as was commonly supposed, according to the tenacity, and that accounted for the difference which was often seen in the wear of railway rails. He also pointed out that in cast-iron the softest metal was really the strongest.

The Industrial Problem.—The *American Machinist* says that, "the great industrial problem is the discovery and adoption of some plan to afford work for the unemployed," and thus concludes its article on the subject by saying, "we believe that no other remedy exists for getting rid of the growing army of enforced idlers, than cutting down the hours of daily labor." This is a very simple remedy for this wide-spread evil, and, like homœpathic medicine, will be pleasant for the laborer to take.

Russian Ship Canal.—Some attention has been directed in Russia to a project for a second connection between the Sea of Azof and the Black Sea by a canal through the Isthmus of Perekop, which connects the Crimea with the main land. As now outlined it is proposed to build a canal 12 feet deep and 65 feet wide through the Isthmus, with ports at each end. The object of the canal is to avoid the dangerous navigation of the Straits of Kertch.

Safety Heating and Lighting.—An Omaha letter says that a new plan for securing safety is to be tried on the Union Pacific road. It is proposed to have an iron car attached to the train, in which will be a boiler to supply steam for heating the cars and the reservoir containing gas for lighting them. No fire will be allowed in any other car, and, as the gas lights in the passenger cars will be at once extinguished in case of accident, it is believed that danger of fire will be almost entirely removed.

Profits for Employes.—H. K. Porter & Co., in Pittsburgh, builders of light locomotives, recently issued a circular to their employés, saying that during the year just closed the work in the shops had been exceedingly well done. To show their appreciation of honest endeavor and fair dealing they therefore make cash presents to all the men in the shops, on the following scale: Foremen, $50 each; gang-bosses, $25 each; mechanics, $15 each; laborers, $10 and apprentices $5 each.

Electric Locomotives in London.—Trials have been made in London of the Elieson electric locomotive. This is a motor driven by a storage battery, the motor being placed below the vehicle and communicating its power to the wheels by bevel gearing. The locomotive weighs 6½ tons and the car attached to it 2½ tons, empty; the car will carry 46 passengers. Locomotives of this pattern are to be used on a suburban section of the North Metropolitan Tramway Company's line. The run is 5 miles each way.

New Ships for the Navy.—The House Committee on Naval Affairs recommends the passage of a bill providing for the construction of two steel cruisers of 4,000 tons burden, to be of the same type as the *Newark*, now building; four steel gunboats of 1,700 tons displacement, and one steel torpedo boat for cruising, to be about 150 feet long and capable of making 20 knots an hour. The cost of the cruisers is not to exceed $1,300,000 each, without armament; of the gunboats, $525,000 each; and of the torpedo boat, $100,000.

Natural Gas in Ohio.—A syndicate has been formed to pipe natural gas from the wells at Findlay, O., to Columbus and Cincinnati. A 4-inch main will be laid. The sydicate controls light wells with an average product of 30,000,000 cubic feet.

In Wood County there are now 18 wells, producing an average of 44,000,000 cubic feet of gas daily.

Arrangements are in progress to put down pipes from the gas wells in Mercer County to Dayton, Springfield and other manufacturing towns.

Wind Derailments on Narrow-Gauge Roads.—A severe wind-storm on February 18 proved too much for the narrow-gauge roads in Colorado, no less than four trains having been blown from the track. On the Denver & Rio Grande a passenger train of 5 cars was blown from the track, and a freight train of 20 cars was also derailed, both near Colorado Springs. On the Denver & South Park a passenger train of 3 cars was blown down a bank near Morrison and another passenger train was blown from a bridge near Como; in the last accident several passengers were hurt.

Large Stationary Engine.—Douglas & Grant, of Kirkcaldy, Scotland, have nearly completed a compound Corliss Engine of unusual size for a cotton mill in Bombay. The engine has a high-pressure cylinder 40 inches, and low-pressure, 70 inches diameter, the stroke being 6 feet. The fly-wheel is 30 feet diameter by 8 feet 6 inches face, and is grooved for 38 wire ropes, by which the power is to be transmitted to the different sections of the mill. The steam pressure is to be 100 lbs. and the engine is to run at 60 revolutions, it is expected to work up to 2,500 H. P. without difficulty.

New Bridge Contracts.—Contracts for two important bridges have recently been let. The first is for a steel bridge over the Ohio River, between Cincinnati and Covington, for the Chesapeake & Ohio or Huntington system of railroads. This bridge will be built by the Phœnix Bridge Company at Phœnixville, Pa.; the cost will be about $1,000,000.

The second contract is for a bridge over the Mississippi at Fort Madison, Ia., for the Chicago, Santa Fe & California, which is the Atchison, Topeka & Santa Fe extension to Chicago. The Union Bridge Company has the contract for this bridge, which has been designed by Mr. Octave Chanute.

Iron-Clad for the Spanish Government.—A large iron-clad, named the *Pelayo*, constructed for the Spanish Government by a French company, was launched at Toulon, recently, having been commenced in April, 1885. The vessel is 105 meters long by 20 wide, and of 9,900 tons. The two engines are of 6,800 horse-power, which can be increased to 8,000, and the two screws, each weighing 7,500 kilogrammes, give a maximum speed of 16 knots an hour. The cost is 14,500,000f., exclusive of that of the hydraulic apparatus and artillery, and the ship will be completely equipped in another year.

Heating Railroad Cars.—Mr. Albert L. Murdock, of Boston, sends to the *Transcript* of that city the following letter: "There are at the Patent Office, Washington, 300 models for heating railroad cars and not one adopted by any railroad company in the United States and never will be until public opinion forces them to action. I will deposit $500 in bank on notice of any one equipping a train of five cars, and after running three months, if accepted by the railroad company and an order is given to equip 25 cars, the sum shall be payable on presentation of the contract to the inventor of the first method that is accepted."

Compound Engines for an Italian Iron-Clad.—Messrs. Maudslay, Sons and Field, the celebrated English engineers, are building large compound engines for the new Italian armor-clad *Il Re Umberto*. According to the contract, these engines are to be of 19,500 horse-power, which is about 7,500 horse-power more than that of any vessel yet designed for the British Navy. It is stated that they will actually indicate 21,000 horse-power, or 9,000 more than any vessel in the British Navy. These engines, completely made of steel, are expected to drive the *Il Re Umberto*, fully equipped, about 20 knots per hour.

Imports of Iron and Steel.—The total imports of iron and steel into the United States last year, as given by the Bureau of Statistics of the Treasury Department, were 1,098,562 tons, of a total value of $41,630,688; against 578,476 tons valued at $31,144,552 in 1885.

The leading articles imported were: Tin plates, 257,686 tons; steel blooms and billets, 149,287 tons; wire rods, 136,965 tons; steel rails, 41,581 tons; pig-iron, 361,768 tons; scrap-iron, 87,103 tons.

The imports of iron ore for 1886 were 1,039,433 tons, against 390,786 in 1885. This ore came chiefly from Cuba and Spain, with a small quantity from the island of Elba.

Harlem River Bridge.—The pneumatic caisson for the new Harlem River bridge, 54 by 104 feet, outside measurement, and one of the largest in this country, is making satisfactory progress. It has struck rock on one edge, 17 feet down, the rock at the other edge being 42 feet down. Drills worked by compressed air are now at work on the rock and the caisson will probably be down to place by April 1. Dynamite is used exclusively for blasting. The ma-

terial is removed exclusively through air-locks, four buckets, holding one-quarter yard each, passing through the lock at once. This caisson was built in place, a sheet pile coffer-dam being built around the site, filled in with silt from the bed of the river.

Chicago Manual Training School.—This school, now in its fourth year, has made encouraging progress under the direction of Dr. Belfield. The total number of pupils enrolled is now 190. The course is a three years' one, and embraces instruction in mathematics, science, language, drawing and shop-work during the entire period. The requisites for admission are, that the candidate be at least fourteen years of age and be able to pass a satisfactory examination in reading, spelling, writing, geography, English composition and arithmetic. The school has a well-equipped wood-room, foundry, forge-room and machine-shop, and ample apparatus for teaching the various subjects in which instruction is given.

Railroads in Ecuador.—The Government of the South American State of Ecuador has granted a concession to Messrs. Finley and Wiswell, two American engineers, to build a railroad from Quito, the capital, to the port of San Lorenzo. It is understood that capital has been secured in New York. A preliminary survey has been made of the road, which will be about 120 miles long, and a practicable route has been found.

By the terms of the concession the Government of Ecuador grants a subsidy equivalent to 6 per cent. upon $27,000 per kilometer (equal to about $45,000 per mile). This grant is not in the nature of a guarantee or claim upon the revenues, but is a direct donation and is secured to the railroad company by charge upon the customs revenues of the port of San Lorenzo.

Electric Lighting in the British Navy.—The official trial of the electric light installation on board H. M. S. *Severn* took place at Chatham Dockyard, and proved entirely successful. The dynamos were Goolden-Trotter A type, one of 200 ampères, driven by a Willan's central-valve two cylinder engine at 400 revolutions, and another of 100 ampères driven by a Willan's three-cylinder tandem engine, also at 400 revolutions. The installation consisted of 171 Swan lamps of 16 candle-power, 80 volts, and two Latimer, Clark, Muirhead & Co.'s projectors, each running a search light of 100 ampères. The installation was fitted up by the firm of Goolden & Trotter, of Westminster, the entire work having been carried out by their own staff.

Suit for Infringement of the Patent of the Miller Coupler.—The case of the heirs of the late Ezra Miller against the Pennsylvania Railroad Company for damages amounting to over $100,000 for the infringement of the patents granted to Miller in 1863, 1865 and 1866 by the use of the Janney coupler was recently decided before Judge Cox and a jury in the U. S. Circuit Court in New York. This is the first time that the Miller patents have been in litigation. The Court held that the 1863 patent was limited in terms and that the Janney device did not infringe it. The Judge then directed that a verdict on the other patents should be given for 6 cents damages, which was consented to by the counsel for the Pennsylvania Railroad Company.

Coal Production of the United States.—The production of coal in the United States for seven years past is estimated by *Bradstreet's* as follows, in long tons:

	Bituminous.	Anthracite.	Total.
1880	37,138,000	25,400,000	62,588,000
1881	42,826,000	30,900,000	73,726,000
1882	51,523,000	31,550,000	83,073,000
1883	57,805,000	34,450,000	92,255,000
1884	60,000,000	33,319,000	93,319,000
1885	58,300,000	34,258,000	92,558,000
1886	66,200,000	34,814,000	101,014,000

The increase last year over 1885 was most notable in Pennsylvania, Indiana, Virginia, West Virginia and Maryland. Pennsylvania furnished all the anthracite and 44 per cent. of the bituminous coal in 1886, or over 63 per cent. of the entire product.

New Guns for the Army.—The *Army and Navy Journal* says: "We are informed that the Ordnance Department are proposing to so alter the Springfield Rifle as to avoid, if possible, the necessity for adopting a quicker firing gun in the shape of a magazine arm. Just what changes are in contemplation we do not learn. As soon as Col. Buffington, of the Springfield Armory, has completed some experiments he is conducting, they will be announced. It is not expected that the gun can be made a self-loader, but the idea seems to be to have the breech block so arranged as as to admit of the most rapid loading with the hand. Gen. Kelton has also an improvement on the Springfield gun which it is thought possesses considerable merit. He is now in consultation with the Ordnance Department with regard to it."

Lectures on Railroad Management.—Professor E. R. A. Seligman, of Columbia College, New York, delivers this winter to the students a course of lectures on railroad history and management. The course is outlined as follows:

1. Railroad history and development in the United States, England and the Continent of Europe.
2. Relations of railroads to investors in their securities.
3. Relations of railroads to the public.
4. Relations of railroads to their employés.
5. National and State legislation on railroads in the United States.
6. The question of State or private ownership of railroads.

Illinois Coal Mines.—The reports of the State Mine Inspector show that in 1886 coal was mined in Illinois in 50 counties, at 789 mines and openings. There were 25,846 employés at these mines, and 235 machines used. The total output for the year was 9,246,435 tons, a decrease of 5½ per cent. from 1885. The average value per ton at the mines was $1.11.

The reports of accidents to miners show that 52 men were killed and 169 injured, a total of 221 casualties. One life was lost for 497 employés, or one life for 177,816 tons of coal mined.

The total number of escapement shafts in mines is now 310, against 137 in 1884, and the total number of mechanical ventilating fans erected during the year was 48, making 152 now in use.

New Locomotives for the New York Elevated Roads.—The Manhattan Company is having 25 new locomotives built for its elevated lines in New York City at the New York Locomotive Works, in Rome, N. Y. Like so many of the engines on the elevated roads, the new ones are of the Forney pattern; they have cylinders 12 inches diameter and 16 inches stroke. The chief peculiarity of these engines is the use of the Belpaire boiler. In these boilers the fire-box is 55 inches long inside and 43 inches wide at the bottom, tapering to 32¼ inches at the top. The outside fire-box is 62¼ inches long and 49⅜ inches wide at the bottom, tapering to 38¼ inches at the top. The fire-box crown-sheet is stayed to the flat, external crown-sheet by stay-bolts spaced 4½ inches apart; these stay-bolts are 1 inch diameter and 22 inches long. The boiler is 42 inches diameter of barrel and has 162 tubes, 7 feet 5¼ inches long.

Electric Lighting.—Mr T. C. Martin, in the *Electrical World*, gives the following estimate of the progress made by two leading systems of electric lighting in the United States, the Brush lights representing the arc and the Edison the incandescent system. The number of lights in use has been as follows:

	Brush Lights.	Edison Lights.
1881	[illegible],000	5,122
1882	12,000	29,192
1883	24,000	64,856
1884	48,000	98,020
1885	96,000	132,875
1886	....	181,463

Mr. Martin estimates the total investment at the close of 1886 in local electric-light plants and in establishments for the manufacture and repair of such plants at $150,750,000.

Underground Telegraphs.—At the recent annual meeting of the Associated Chambers of Commerce of the United Kingdom, Mr. Linley Watson (Scotland) moved: "That in consequence of the frequent interruption of telegraphic communication by storms, the Government be requested to take steps to have the principal lines of wires conveyed under ground." He explained that it was only intended to apply to the great telegraphic lines of communication which, in the interests of the country, it was so necessary to maintain uninterrupted, and he referred to the serious wreckage of wires last month which had paralyzed the commercial world, and said that such breakdowns would occur again and again until aerial wires were abandoned, and the main lines were placed underground. The resolution was agreed to, and it was determined that a representation should be made to the Government.

Winter Bridge over the Detroit River.—A plan for a railroad bridge over the Detroit River, to be used only in winter when navigation is closed, has been submitted by Chief Engineer J. D. Hawks, of the Michigan Central Railroad. The plan is for a bridge with two draw-spans, one with 200 feet opening near the Michigan side, and one with 300 feet opening on the Canadian side of the river. There will also be five fixed spans, one of 200 and four of 300 feet each. In addition to these, there will be a span of 400 feet over the main channel, to be removed when navigation is open.

This plan is said to have met with approval from a committee of Congress. Should it be pressed it will be strongly opposed by the navigation interests, whose representatives hold, with much

reason, that if so expensive a structure is once built, it will not be long before some plan is devised for using it in summer as well as in winter.

Continuous Brakes in England.—The return for the six months ended June 30, 1886, showing the extent to which the continuous brakes are used on the principal railways of Great Britain, has been issued. It shows that the total stock fitted with continuous brakes, complying and not complying with the requirements of the Board of Trade, for the six months ending June 30 last, and the stock not so fitted were:

	Locomotives,		Carriages,	
	Number.	Per cent.	Number.	Per cent.
With continuous brakes....	6,631	89	43,238	83
Without continuous brakes	849	11	8,552	17

Of the total train mileage reported on the railroads for the half-year, 84 per cent. was run by trains with continuous brakes.

During the half-year 358 engines and 3,030 carriages were added to the number provided with continuous brakes.

Railroads in Porto Rico.—The Spanish Consul at New Orleans, Senor Don Arturo Baldasano y Topete, has received a circular from the home government requesting him to call the attention of the public to a recent decree concerning the construction of several railroads in Porto Rico. The Government promises the parties who may secure the contract an interest of 8 per cent. on the capital which will be invested by it, and also the exclusive control of the roads during 99 years. The work is to be completed in 6 years. A bond of $300,000 and a deposit of $100,000 are required by the contract. Mr. Baldasano states that the work to be done consists of five railroads, which will web the island so that every place will be in close communication. The Consul thought this was an opportunity for some southern enterprise to do well, and therefore stands ready to give any further information desired.

National Association of Stationary Engineers.—This Association has issued a circular setting forth its principles as adopted at the annual convention held in Boston in September last. The Association is not intended to be a trades-union in the ordinary sense, but an association for the purpose of elevating the trade and putting it on a better footing than heretofore. The objects sought to be attained are stated in the circular as follows:

"1. To elevate the profession.

"2. To secure a legal or recognized status for operating steam engineers.

"3. To elevate and help its members.

"4. To secure the confidence of steam users.

"5. To prevent entirely the explosion of steam boilers.

"6. To permit only licensed engineers to operate boilers under pressure."

The Heaviest Gun Made in England.—The first 110-ton gun, the heaviest weapon ever made in England, was safely conveyed to the proof butts at Woolwich Arsenal, recently, for the purpose of undergoing its preliminary trials. The gun had previously been placed on the carriage from which it will be fired, and this, being fixed on a broad-gauge trolly, was easily taken over the Arsenal railway by four large locomotive engines. The carriage weighs nearly 100 tons, independently of the gun. The bore of the gun is 16¼ in., and it will fire a projectile of 1,800 lbs. weight, but the charge of powder cannot be determined until after full trial. The proof will begin with a small quantity and be gradually increased as the powers of the gun are demonstrated. A new powder, specially manufactured for very large guns at the Government works, Waltham Abbey, will be employed in the experiments. The gun was supplied under contract by the Elswick firm.—*Engineering.*

Prices of Rails.—The *Iron Age* gives an interesting statement of the prices of steel and iron rails in the United States for a series of years. For the 13 years from 1848 to 1860, inclusive, the average price of iron rails was $58 per ton, the highest price being $81 in 1854, and the lowest $43 in 1851. In the 13 years from 1861 to 1873, inclusive, the average price was $78.15, the highest price being $153.75 (currency) in 1864, and the lowest $36.50 in 1861. For the nine years from 1874 to 1882, inclusive, the average price was $44.43 per ton, the highest being $68 in 1880, the lowest $32.50 in 1877. With 1882 the manufacture of iron rails in this country practically ended, and the substitution of steel on the market was complete.

The price of steel rails in the 13 years from 1874 to 1886, inclusive, ranged from an average of $94.25 per ton (the highest) in 1874, to an average of $28.50 (the lowest) in 1885. The average price for the 13 years was $51.39. The highest single quotation was $117.50, early in 1874; the lowest, $26 in 1885. The present price is about $40, which is above the average for the four years from 1883 to 1886, inclusive.

Lifeboat Services.—It is reported that in England during the past year service in saving life was rendered by the gallant crews of the lifeboats of the Royal National Lifeboat Institution, resulting in the rescue of 601 persons from danger, and in most cases from death. In addition to this long list of services in saving life, it should be added that as many as 33 vessels were saved by the lifeboats from total destruction, or were helped by them into a haven of safety. Besides the launches resulting in the saving of life, the lifeboats put to sea as many as 147 times in reply to signals of distress, only to find either that their aid was not really required, or that the signals had been made in error or improperly.

In the year the Society also gave rewards for the saving of 160 lives by means of shore-boats, fishing-boats and other means, so that the Institution was instrumental in rescuing a grand total of 761 lives during 1886, bringing up the number of lives it has saved since its foundation to 32,671.

Heating Cars by Hot Air.—A new method of heating cars from the locomotive is to be tried on the Allegheny V ley road. The details are not yet completely arranged, b the general plan is described as follows by General Superintendent David McCargo: "Heated air is absolutely safe, and can be generated from the locomotive at a trifling expense. The principle is similar to the air-brake principle and just as practicable. An air-pump forces the air along the cars for the brake system. Why should a pump not force heating air also? Plenty of air could be had from the fire-box of the engine. There is always plenty to spare, and in fact large quantities wasted. The hot-air method would cause no danger, because if any break occurred there would be no possible chance of fire or explosion. Of course if this plan is adopted all locomotives will be equipped with suitable appliances to carry it out. I mean both freight and passenger engines, because the former are sometimes used on passenger trains."

Railroad in the Arctic Circle.—English papers announce the opening of the Lulea-Ofoten railroad, which extends from Gellivara in Swedish Lapland to the port of Ofoten on the west coast of Norway. The road is built to carry iron ore from the mountain range near Gellivara to Ofoten, whence it will be shipped to England. This ore is said to contain 70 per cent. of metallic iron, and with the opening of the new railroad it can be delivered at English ports at about the same price per ton as the Spanish ore from Bilbao, which is only 50 per cent. metallic iron. Gellivara is in latitude 67° north, so that the eastern terminus of the road is north of the Arctic Circle. Ofoten is only a little south of that circle, but it is stated that the influence of the Gulf Stream keeps the average winter temperature down to about 25° Fahr., so that no trouble is expected from the closing of the port by ice. It may be supposed, however, that a railroad so far north would have some trouble from snow, especially as much of the line is in a mountain country.

Cost and Consumption of Oil on British Railways.—The detailed accounts of the Manchester, Sheffield & Lincolnshire Company, says *The Engineer*, show a result which will surprise many of our readers in the fact that the saving effected in the locomotive department—the chief one in economy—is due, in a great measure, to "oil and tallow." That a saving of nearly £2 000 could be effected in this one item alone need not be cause for astonishment, when we consider the enormous consumption of these articles for lubricating and illuminating purposes. A contemporary gives the annual consumption of oil upon the railways of the United Kingdom roughly, as follows: Engineer's department, £30,000. Locomotive department, running, £225,000; shops, £25,000; carriage lighting, £40,000. Traffic department, £40,000; general offices, etc., £10,000. Total estimated cost, £370,000; or, say, at 6d. per gallon, 14,800,000 gallons a year. The average cost per train mile of "oil, tallow and waste," in the locomotive running expenses is 0.267d. per train mile. Oil by itself may be taken at about 0.2 per train mile, which, on a fair aggregate mileage, would give the £225,000 above estimated as the cost in this department on all the lines.

New York Underground Railroad.—This company has been reorganized, and a contract for building the road has been let to the United States Subway Company. Application has been made to the Commissioner of Public Works for authority to open the streets in order to begin the work. The excavation required will be 25 feet wide and 15 feet deep. The directors claim that the company's charter

gives all the authority needed to build the road, and that nearly all the property owners along the proposed route are in favor of it. The proposed route is from Broadway, under City Hall Park to Brooklyn Bridge, thence up Center street to City Hall Place, thence to Mulberry Street, northerly to Bleecker Street to Lafayette Place, under Lafayette Place to Astor Place, under Astor Place and Poole's Theatre to Fourth Avenue at the Stewart Building, thence north under Union Square to Broadway, up Broadway to Eighteenth Street, thence to Madison Avenue and under Madison Avenue to the Harlem River.

A branch will run from Broadway and Eighteenth Street to the southwest corner of Central Park, and another branch from City Hall Park to the Battery.

Coast Survey Work.—Lieutenant Pillsbury, commanding the *Blake*, has started south for the season's work, and will run several lines of current observations from Cuba to Yucatan, and from Cuba to Florida Reef, and thence northward to San Antonio. This is a continuation of the work of last year, which was so successful. The connection between the velocity of the Gulf Stream and the advent of the tidal wave on our coast has been accurately determined, and the credit for this important discovery is due to Lieutenant Pillsbury.

The steamer *Patterson*, which has been laid up since last October at the Mare Island Navy Yard, is being overhauled and painted, to return to survey work on the Alaska coast early in the coming spring.

Lieutenant William H. Emory, who commanded the *Bear* on the Greely relief expedition, has been ordered to the *Thetis* and will shortly sail for Alaska. He will investigate the seal-fisheries, and has received special instructions regarding the boundary line between Alaska and the British possessions.

Racing Yacht on a New Model.—Lieutenant S. Seabury, U. S. N., has designed a new type of sloop yacht which is a compromise between the "skimming-dish" and "cutter." The vessel submitted has been given a load line as fine aft as it is forward while the smaller angles of the cross sections with the center line insure a smaller change in the flotation plane by inclination. Naturally, a loss of initial stability results, but then the greater draught enables ballast to be carried where it will do the most good. The proposed vessel has her greatest draught at the middle of her length, which is also her greatest cross section. The *New York Herald*, which publishes plans of Lieut. Seabury's yacht, says: "As an interesting experiment her plans are worthy of close study, and her performance when built will be watched with eager curiosity by nautical men. Her designer believes in her, and if she accomplishes half what is claimed for her she is perhaps destined to make a great revolution in the present methods of yacht construction in both the United States and Great Britain."

New York Water Supply.—The New York Aqueduct Commission has resolved, with only one dissenting vote, in favor of building the proposed Quaker Bridge Dam, in order to provide an additional storage reservoir. The water-shed of the Croton River, it is believed, will yield a sufficient supply for the city for many years to come, but the present storage capacity is insufficient, and in seasons of high water much water passes over the dam and is wasted. The new dam will form a reservoir or lake holding about 34,000,000,000 gallons more than can be stored at present.

The proposed new dam, if built in accordance with the preliminary plans submitted by the Engineers, will be 1,025 feet long. It will be in the center 178 feet high from the present bed of the river and 278 feet from the rock foundation, which will be 100 feet below the river-bed. It is below the old Croton Dam and will be about 35 feet higher than that structure, which will thus be submerged entirely when the reservoir formed by the new dam is full.

This vote of the Commission closes a long controversy over the best means of meeting the difficulties in the case.

A Prairie Snow Yacht.—Dr. H. M. Wheeler, of Grand Forks, Dak., has designed and built a modified form of ice-boat for his own use. His new craft sails over the snow on the prairies at the rate of from 13 to 16 miles an hour, and even faster when there is a good hard crust on the snow. The yacht is 32 feet in length, width abeam 14 feet, mast 20 feet, main boom 22 feet, gaff 12 feet, jibboom 11½ feet. The runners are strong toboggans 9 feet long, the front ones being 1 foot, and the rear ones 6 inches wide. The front runners have a central shoe 2 feet long, projecting 1¼ inches to prevent drifting. The body of the boat is raised above the runners 1 foot. The frame work is 3 feet across the stern, and the tiller is attached directly to the rear runner. Dr. Wheeler says in his letter: "Our country is a vast table land, and, with the exceptions of ravines and water courses, is apparently as level as the floor. We have no fences, except small enclosures for stock, hence we have plenty of 'sea room.' My mast is as high as will go under telegraph wires, and even now sometimes encounters them, on which account I have rigged an iron fender, shaped like an old-fashioned figure 4, with a line running from front angle to bowsprit. When the front face of this 4 strikes a telegraph wire the wire bounds up and over it and the yacht passes along."

English Trade Unions.—An appendix to the report of the Chief Registrar of Friendly Societies for 1885 furnishes a list of 207 trade unions in England, together with details of their organization. It appears that the oldest union which is still in active existence is the Steam Engine Makers' Society, which has its headquarter at Manchester and was established in 1824. Then come the General Union of Operative Carpenters and Joiners started at Liverpool in 1827, and the United Society of Boiler-makers and Iron Ship-builders, of Newcastle-upon-Tyne, originated in 1834. Every well-known trade is represented on the list of unions, but there are also in addition such industries as stuff makers-up, card-setting machine tenters, drillers and cutters of the River Wear, Dutch yeast importers, trimmers and teemers, crabbers and singers, silk ballers, potters' mold-makers, card and blowing-room operatives, boot-top cutters, hammermen, tin-canister makers, carriage straighteners, tape sizers, chippers and drillers, and rundlet coopers. The amalgamated chimney sweeps have a separate union, as likewise have the amalgamated showmen and amusement caterers. The latter union, however, was very short-lived; founded in 1884, it was dissolved in 1886.

Russian Oil-Pipe Line.—The Russian Government has just granted a concession for a pipe-line to connect the Baku oil-fields with the port of Batoum on the Black Sea. The concession is to last 20 years, with the proviso that the first line shall be completed within three years. The Government not only guarantees no interest, but stipulates that the pipe-line company shall not, during the term of concession, own or have any interest in either oil wells or oil refineries. Wherever the lines traverse Government lands, no charge for right of way will be made, and everywhere the company will have the same rights and privileges as are granted to railroads. One-third of the pipes must be constructed in Russia, unless such is proved to be impossible. The tariff for the pumpage of the oil has been fixed at from 10 to 11 copecks a pound, equal to about 1.10 cents a gallon.

The whole length of the line will be 603 miles. The pipe-laying will be easy all along, except where the line crosses the Caucasian Mountains This will be accomplished at the Suram Pass, which is about 3,000 feet above the sea-level, by a series of pumping stations furnished with large Worthington pumps. The gravity of the oil itself will carry it from the summit of the pass down to the sea-level at Batoum.

Open-Hearth Steel Production.—The American Iron & Steel Association gives the production of open-hearth steel in the United States last year at 245,606 tons, against 149,381 in 1885.

"The output of open-hearth steel in 1886 was produced by 31 old and 8 new plants, located in eight States—New Hampshire, Massachusetts, New York, New Jersey, Pennsylvania, Ohio, Illinois and California. Of the new plants one is in Massachusetts, 6 in Pennsylvania and one in Ohio. Three open-hearth plants built prior to 1886 were not in operation in that year. At the close of 1886 there were also 9 new open-hearth plants which had either been built in that year but not put in operation, or were then building or were projected by responsible parties. Of these 5 were in Pennsylvania, 2 in Ohio and 2 in Indiana.

"Pennsylvania's share of the total production of 1886 was over 70 per cent.

"The quantity of open-hearth castings produced in 1886 was not materially larger than in previous years, and was relatively very small. The quantity of open-hearth steel rails produced in 1886 by open-hearth works was also very small, amounting to only 5,255 net tons, which were made in Pennsylvania and California. Of the whole quantity 2,518 net tons were street rails."

Transmission of Power by Compressed Air.—A company is about to make the experiment in Birmingham, England, of transmitting power by compressed air over an area of about one square mile and a half, which will include about twenty-three miles of main pipes. Commenting on this a writer in *Nature* says:

"This is the first time that an experiment of this kind has been tried in Britain. Power is distributed from a central station at Hull by the hydraulic system, but transmission by air

has hitherto only been tried in small installations at mines, quarries, in sinking piers, as at the Fourth Bridge, and in tunnel-boring. In mines and tunnels it has very evident advantages, in that it keeps up a continual supply of fresh, cold air where ventilation is very much needed; and therefore its undoubted success at the St. Gothard works does not demonstrate its certainty of success for the distribution of power on a large scale to the workshops of a town where the atmosphere is bareably pure. Moreover, the pipe system of these small installations have not been sufficiently long and complicated to test in any severe sense the liability to loss by friction, leakage and variation of temperature.

"The results of the present experiment wiil therefore be of the utmost scientific value to engineers, and will be watched with corresponding interest."

School for Inventors.—Professor R. H. Thurston writes to the *Scientific American* that a pet project of the late John Roach was the foundation of a school for inventors. In this school he "would make it possible for the needy inventor to find all the tools, apparatus for experimentation, facilities for construction and operation of his invention; whatever, in fact, he might in any way find useful in its development, and even the aid of experienced mechanics and of learned men of science, all placed freely at his disposal; so that he might, quietly and comfortably, go about his work with an assurance that, if there was anything at all in his notion, it should be most certainly and promptly and effectively given working form and useful application.

"Mr. Roach believed, as he said, that such an institution might, if properly organized and well managed, be made to return to the country many times its cost by securing the immediate development of valuable inventions and their prompt applications where, without such aid, they might lie dormant and useless for years, or even be lost to the world altogether. As he put it, the successful development of a single such invention might give to the world the equivalent of millions of dollars in facilitating production, saving lives and property or in promoting the comfort of the people."

Mr. Roach died before he felt himself in a position to carry out this project, and his ideas remained undeveloped.

New Use for Blast-Furnace Slag.—The *American Manufacturer* says that Mr. John Q. Everson and two well-known capitalists of Pittsburgh are organizing a company for the purpose of converting blast-furnace slag into mortar and other building material.

Mr. Everson has experimented for some time and finds that if certain materials, known to himself, are added to the slag when it is run from the blast furnace into a pit prepared for that purpose, that it forms a hard substance suitable for making mortar, pavements, etc.

It is the intention of the new company to at once erect a plant convenient to some large blast furnaces. The capital stock will be sufficient to erect a plant large enough to supply the demand for material next year.

After experimenting with this slag compound for nearly three years, Mr. Everson has arrived at the conclusion that the uses to which it can be put are manifold, and he feels certain that before many months its manufacture will be one of the great industries of Pittsburgh and vicinity. His experiments, he claims, have shown him that blast-furnace slag makes the best and cheapest mortar. The bricks are durable and do not require any kiln drying. The blocks made from it can be used in place of stone sills, lintels, cornices and belting course. It is excellent for cellar walls, as it keeps out all dampness. It will also, it is claimed, make a substantial and durable pavement. The making of subway conduits for electric wires is another use suggested for the new material.

Hardened Petroleum as Fuel.—A report recently made to the Russian Government by Dr. Kauffman says: "Petroleum, which is a hydrocarbon of the so-called methane group, may be saponified just like the oils, fats, fatty acids and wax, thus oxidizing the oil and combining it with soda or potassa salts. For this purpose the oil is heated, and from 1 to 3 per cent. of its weight of common soap is added, with which it is boiled for about half an hour. After that time it will be noticed that the soap is all dissolved in the oil, and the fluid will suddenly turn into a hardened putty-like substance which will get as hard as stiff tallow when cold. This may be pressed into any shape desired. The substance is very hard to light and burns very slowly, without making any smoke, with a reddish flame producing great heat, and leaving about 2 per cent. odorless, black and hard residuum. Compared with coal, it burns about three times slower, producing, if the draught be well regulated, about seven times more heat than anthracite coal. It could well be used in a stove specially constructed for the purpose, or in the old stoves, if these are changed, which will not be very difficult. It is, therefore, very probable that petroleum will take the place of coal in many instances, in the near future, which fact stove manufacturers will have to take into consideration."

Should these statements prove correct, it is claimed that solidified petroleum can be put on the market at lower rates than coal, as it can be piped to convenient points at less expense than coal can be carried, and the works for solidifying can be placed wherever desired.

Steel Rail Production.—The production of Bessemer steel and steel rails for last year and 1885 is given by the *Bulletin* of the American Iron and Steel Association as follows, in net tons:

	1886.	1885.	Increase.
Ingots	2,541,493	1,701,762	839,731
Steel rails	1,749,899	1,074,607	675,292

Last year 69 per cent. of the total production of steel ingots was converted into rails, against 63 per cent. in 1885.

Last year 59 per cent of the ingots and 63 per cent. of the rails were made in Pennsylvania; 21 per cent. of the ingots and 25 per cent. of the rails in Illinois, the balance in other States.

The production, both of ingots and rails, was the largest on record in the United States. In the total production of ingots 46,371 tons made by the Clapp-Griffiths process are included.

The *Bulletin* says: "The extraordinary production of Bessemer steel in 1886 was chiefly the result of great activity by the large plants of the country which had been established prior to that year. Only a small part of it, about 100,000 tons, was due to the starting up of new plants. * * It is just 20 years since Bessemer steel was first made in this country as a commercial product. In 1867 we made 2,277 gross tons of Bessemer steel rails. In recent years we have frequently made more Bessemer steel ingots and more Bessemer steel rails than Great Britain, but, as our production of open-hearth steel was always much less than that of the mother country, we could never until now say that our aggregate production of steel exceeded hers in any year. In 1886, however, we not only made more Bessemer steel ingots and Bessemer steel rails than Great Britain, but our aggregate production of steel, open-hearth and crucible included, was very much larger."

Blast Furnaces of the United States.—The record kept by the *Iron Age* gives the number and capacity of furnaces in blast in the United States on February 1 as follows:

Fuel.	Number.	Weekly Capacity.
Anthracite	136	40,956
Bituminous and Coke	144	78,957
Charcoal	58	9,649
Total	338	129,562

As compared with January 1, the anthracite furnaces show an increase of 6 in number and 220 tons in weekly capacity; the bituminous furnaces, an increase of 7 in number and 5,535 tons in capacity; the charcoal furnaces, a decrease of 1 in number and 1,052 tons in capacity.

New Railroad Built in 1886.—The following statement of new railroad built in the United States in 1886 is issued by Messrs. Poor & Greenough, publishers of *Poor's Manual:*

	Miles.
New England	41
Middle States	374
Central Northern States	1,232
South Atlantic States	1,019
Mississippi Valley States	339
Southwestern States and Territories	2,427
Northwestern States and Territories	2,578
Pacific States and Territories	638
Total	8,648

"This makes the total mileage in the United States at the close of the year 137,615 miles. The reports received from the various railroad companies, of work which is in progress or under contemplation, indicate that construction during the year 1887 will amount to not less than 12,000 miles, unless some serious convulsion should occur to reverse plans which are now entertained.

"This estimate is confirmed by engagements which have been made in advance for the current year with rail mills and other manufacturers of railroad plant."

Portable Railroad Bridges.—A late number of *La Genie Civile* describes a new system of portable railroad bridges, for which simplicity of construction and ease of erection are claimed. The bridges are constructed of a number of triangular pieces formed of angle-iron joined together by gussets riveted in the workshop. The pieces are bolted together to form continuous girders up to a length of 148 feet, and, being made of steel, can bear a strain of 6⅓ tons per square inch of section. The triangles are isosceles, 20 feet long and 10 feet high and weigh 802 lbs. and are the heaviest parts of the bridge. Each girder is terminated by a half-piece 10 feet long, and provided with an upright, and weigh-

ing 639 lbs. The ties are of an angle-iron form, 10 feet long, and weighing 386 lbs. The above pieces serve for the construction of three different types of girders—namely, a single girder, 10 feet 1 inch high, for bridges up to 49¼ feet span; a double girder of the same height for bridges not exceeding 98½ feet span; and, lastly, a double girder, 19 feet 4 inches high, for bridges of from 98½ to 147¾ feet span. The weight of these bridges varies between 13½ tons for bridges of 49¼ feet span and 77⅓ tons for the heaviest form of bridge of 147¾ feet span. It is stated that, owing to the small number of bolts required to connect the several pieces, the lightness and small number of parts and the simplicity of the joints, the erection of the girders is both simple and rapid, and can be effected on scaffolding or by rolling out. One of these bridges has been used for the passage of the Orleans Railway across the river Oust during the rebuilding of three bridges crossing the river. The same bridge was employed at the three sites successively, and the largest of the four spans, having a length of 88½ feet and weighing 33 tons, was put together and rolled out into position in twenty hours. This bridge bore the trial test-loads without any permanent deflection; it carried the traffic for about 150 days altogether, and, like other bridges of this type, proved satisfactorily rigid.

Pig Iron Production in the United States.—The *Bulletin* of the American Iron and Steel Association says: "The production of pig-iron in this country in each year from 1880 to 1886 was as follows, in both net and gross tons.

Years.	Net tons.	Gross tons.
1880	4,295,414	3,835,191
1881	4,641,564	4,144,254
1882	5,178,122	4,623,323
1883	5,146,972	4,595,510
1884	4,589,613	4,097,868
1885	4,529,869	4,044,526
1886	6,366,688	5,684,543

"Our production of pig iron in 1886, classified according to the fuel used, was as follows, in net tons, compared with the production in 1884 and 1885.

Fuel used.	1884.	1885.	1886.
Bituminous	2,544,742	2,675,635	3,806,174
Anthracite	1,586,453	1,454,390	2,099,597
Charcoal	458,418	399,844	460,917

"The anthracite figures include all pig-iron made with mixed anthracite and coke, as well as that made with anthracite alone. In 1886 the total quantity of pig-iron made with anthracite alone was only 443,746 net tons.

"There was a gratifying increase in our production of spiegeleisen in 1886, which is included in the figures of total production of pig-iron. We made 47,982 net tons in 1886, against 34,671 tons in 1885. Only New Jersey and Pennsylvania made spiegeleisen in 1885, but in 1886 Colorado made 932 net tons in addition to the production of the two other States mentioned.

"The gain in production in the last six months of 1886 over the first six months was chiefly in Pennsylvania and Illinois. The total gain in the country at large was 458,270 net tons, and to this gain Pennsylvania and Illinois jointly contributed 320,238 net tons. The great activity in the manufacture of Bessemer steel in these two States in the last half of the year mainly accounts for their increased production of pig-iron."

Technical Education.—At the last meeting of the School Principals' Association in New York, Dr. W. H. J. Sieberg gave a lecture on Technical Education. After saying that the question of introducing manual training into education dated back two centuries, Dr. Sieberg said the reasons which called for technical education were most pressing. They were manifest in the almost universal tendency of public school pupils to enter the professions or clerical pursuits, leaving skilled labor to be undertaken by foreigners. This distaste for manual labor and contempt for all kinds of mechanical arts is the natural result of the almost exclusive training of memory and the reasoning powers. Education should fit a man to work with his hands and eyes as well as with his memory. The pupil should not be influenced in the direction of commercial pursuit any more than in the direction of any of the trades. One of the greatest difficulties to overcome was the education of the teachers themselves. They, as yet, did not understand what was to be taught.

Mr. Henry Leipziger, Principal of the Hebrew Technical Institute, at No. 34 Stuyvesant Street, New York, followed with an address warmly advocating the introduction of technical training and emphasizing the difference between it and industrial or trade instruction. He showed some wonderfully good specimens of mechanical drawing, joinery and casting done by boys in his school between the ages of 12 and 14. He stated that in the three years in which his school had been in existence not one case which could be called a breach of discipline had occurred. "Whatever evil there may be in the boys," said Mr. Leipziger, "is worked off through their fingers, and I actually have hard work sometimes to get the boys away from the school-room at the closing hour, so fully are their energies engaged."

Considerable discussion followed this address, and the general opinion was that though New York public schools were among the best managed and most successful in the world, the results of this technical school were, as one gentleman expressed it, "most humiliating to us as compared with the results of the old, spelling-book method."

Imperial Institute of the United Kingdom, the Colonies and India.—It is proposed to establish in London, in commemoration of the jubilee year of Queen Victoria's reign, an Imperial Institute which, as expressed by the Prince of Wales, at a recent meeting of the members of the organizing committee held in London, "will form a practical means of communication between our colonial settlers and those persons at home who may benefit by emigration. * * * I therefore commend to you as the leading idea I entertain that the Institute should be regarded as a center for extending knowledge in relation to the industrial resources and commerce of the Queen's dominions. With this view it should be in constant touch, not only with the chief manufacturing districts of this country, but also with all the colonies and India. * * * The Imperial Institute should be a supplement to, and not a competitor with, other institutions for technical education in science and art both at home and in the colonies. At the same time, I trust that the Institute will be able to stimulate and aid local efforts by directing scholarships for the working classes into suitable channels, and by other similar means. (Hear, hear!) Though the Institute does not engage in the direct object of systematic technical education, it may well be the means of promoting it as its purpose is to extend an exact knowledge of the industrial resources of the Empire. It will be a place of study and resort for producers and consumers from the colonies and India when they visit this country for business or pleasure, and they, as well as the merchants and manufacturers of the United Kingdom, will find in its collections, libraries, conference and intelligence rooms the means of extending the commerce and of improving the manufacturing industries of the Empire."

At another meeting to promote the Institute, Professor Huxley said that "his memory went back far enough to call to mind with great vividness a period when industry, or, at least the chiefs and the leaders of industry, looked very much askance at science. The practical man then prided himself on caring nothing for it, and made it a point to disbelieve that any advantage to industry could be gained by the growth of what he was pleased to call abstract and theoretic knowledge. But within the last 30 years, more particularly, that state of things had entirely changed. There began in the first place a slight flirtation between science and industry, and that flirtation had grown into an intimacy, he might almost say courtship, until those who watched the signs of the times, saw that it was high time that the young people married and set up an establishment for themselves. (Laughter and cheers.) This great scheme from his point of view was the public and ceremonial marriage of science and industry. (Hear, hear!) It was the recognition on the part of those persons who were best able to judge of what were the wants of the industry of the time, that if they were to be developed in a way proportionate to their importance they must be developed by scientific methods and by the help of a thoroughly scientific organization."

A Locomotive for Sharp Curves.—The Taunton Locomotive Works have just completed a locomotive for local passenger service on the Providence, Warren & Bristol road, which has been built with special reference to working over the very sharp curve by which that road enters Providence. This curve was laid out about a year ago by Mr. Waterman Stone, Superintendent and Engineer of the road. Beginning with a radius of 271 feet, the radius of curvature decreases every 50 feet until a minimum of 211 feet is reached. At the end of this curve the radius is increased every 11 feet until a tangent is reached.

The new locomotive, which is named the *Annawomscutt*, is of the Forney pattern with the addition of a four-wheel truck in front. It has 17 × 20 inch cylinders and drivers 63 inches diameter; one pair of drivers have flanged tires 5¾ inches space, the other blank tires 7 inches face. The driving-wheel base is 6 feet 9 inches; the total wheel base, 31 feet 2 inches. The boiler is 54 inches diameter of barrel, and has 170 tubes 2 inches diameter and 10 feet 10 inches long. The fire-box is 60 inches long and 34½ inches wide inside; the fuel is soft coal.

The arrangement of the trucks is described as follows: "The engine and tender are all borne on one rigid frame, in which the four coupled driving-wheels are placed as in an ordi-

nary eight-wheeled engine. There is a leading truck of four wheels and a tender truck of six wheels. The engine is set upon these two trucks in a new and quite peculiar manner, and on their smooth working depends her successful passage of the great curve. The trucks are both swiveling upon a center bearing and oscillating, having a play or slide of 1 foot, or 6 inches right and left. The center bearing of the truck is made broad and concave, the angle of inclination of the sides of the dish-shaped bearing differing in the tender trnck from the leading truck on account of the greater weight at that end of the machine. Between this and the complementary convex bearing, supporting the frame on either truck, are interposed hard steel rolls, the forward truck two and the tender truck four, working freely in their bearings. When the engine strikes a curve the extremes of the frame will be carried out over the outside of the curve, and the trucks following, the rails will bring the weight upon the roller bearings, which will tend to bring the truck back to the true center bearing when the tangent is reached. The trucks at the extremes of the machine thus looking after themselves upon curves the rear pair of drivers only need strictly follow the main line of track, the broad tread of forward drivers, which are blank, allowing a considerable side motion. The engine truck is entirely forward of the cylinders, and its wheel-base is but 3 feet 2 inches, reminding one of the close-wheeled leading truck of an old-fashioned inside-connected engine."

The engine truck wheels are 26 inches, and the tender wheels 30 inches diameter; they are all of Krupp steel.

The engine weighs, empty, 99,700 lbs., of which 13,500 lbs. are on the forward truck, 55,000 on the drivers and 31,200 lbs. on the tender truck. The tank will hold 2,200 gallons of water, and the tender will hold three tons of coal.

The Size of Ocean Steamships.—The following table gives the name, date of contruction, tonnage, length, breadth and depth of the principal steamships plying between European and American shores:

Name.	Built.	Gross tonnage.	Length.	Beam.	Depth.
City of Rome	'81	8144	546	52	37
Umbria	'84	7800	500	57.2	38.1
Etruria	'84	7718	501.6	57.2	38
Servia	'81	7392	515	52.1	37
Aurania	'82	7269	470	57.2	37.2
Le Bretagne	'86	7012	508.4	52.4	38.4
La Bourgogne	'86	7000	508.6	52.2	38.8
La Champagne	'86	7005	508.7	51.6	38.4
La Gascogne	'86	7008	508.7	52.2	38.3
Alaska	'81	6932	500	50.6	38
America	'83	6500	432	51.3	35.8
Normandie	'82	6062	459	50	37
Westernland	'83	5736	455	47	35
Saale	'86	5500	455	48	38
Trave	'86	5500	455	48	38
Aller	'86	5500	455	48	38
City of Berlin	'74	5491	488.6	44.2	34.9
Noordland	'83	5212	400.7	47	35.3
City of Chicago	'83	5202	430	45	33.6
Eider	'83	5200	450	47	33.6
Arizona	'79	5147	464	46	37
Ems	'84	5129	430.5	47	34.5
Fulda	'83	5109	450	46	36
Werra	'82	5109	450	46	36
Belgravia	'81	5080	398.2	44.5	32.2
Germanic	'74	5008	455	45.2	33.7
Britannic	'74	5004	455	45.2	33.7
Elbe	'81	4911	420	45	36.5
England	'65	4898	437	42.5	35
Egyptian Monarch	'80	4709	370	44	35.8
Egypt	'71	4610	440	44.3	36.5
France (Fr.)	'65	4647	384	44	36
Amerique	'64	4637	394	42.0	36.9
City of Richmond	'73	4607	452.6	43	36
Erin	'64	4500	415	41	35
City of Chester	'73	4565	475	44.3	35
Spain	'71	4512	425.4	43.2	36.2
City of Montreal	'71	4451	419.1	44	34.3
The Queen	'65	4457	381.1	42.4	37.3
Grecian Monarch	'82	4364	381	43	33
Greece	'63	4310	390.7	41.3	35.3
Devonia	'77	4269	400	42	32
Hammonia	'82	4247	375	45	34
Italy	'70	4169	389	42.3	38.7
Anchoria	'74	4168	480	40.1	33.8
State of Nebraska	80	4000	385	43	34
Ethiopia	'73	4005	402	40.2	33
Lydian Monarch	'81	3916	360	43	32.4
Adriatic	'71	3888	437.2	40.9	31
Celtic	'72	3867	437.2	40.9	31
Denmark	'65	3724	342.9	42.2	36
Republic	'71	3707	420	40.9	31
Baltic	'71	3707	420	40.9	31
Suevia	'74	3704	360	41	34
Wisconsin	'70	3700	378	43.2	32

Other well-known ships are the *France*, *State of Nevada*, *State of Pennsylvania*, *Monarch*, *Rhynland*, *Abyssinia*, *Australia*, *Lessing*, *Wyoming*, *Rugia*, *Belgenland*, *Wieland*, *State of Alabama*, *Westphalia*, *Pennland*, *Zeeland*, *Assyrian Monarch*, *State of Georgia*, *Bohemia*, *State of Indiana*, *Acadia*, *Nederland*, *Alexandria and Assyria*. These register from 3,600 to 1,082 tons. The *Acadia* is the smallest.—*The Engineer.*

Improvement of New York Harbor.—At a recent meeting of the Engineers' Club of Philadelphia, Prof. L. M. Haupt made some remarks on the plans for the improvement of New York Harbor, and on a pamphlet on the subject recently issued by the New York Chamber of Commerce. These remarks are reported in the *Proceedings* of the Club as follows: "He said, with reference to the jetty plan proposed by the Board of U. S. Engineers, that he had previously given his comments in his papers entitled Harbor Studies, which are now published in Vol. V, No. 4, of the *Proceedings*. There were a few statements, however, in the circular issued by the Chamber of Commerce to which he desired to call attention, since he believed that the plan proposed in said pamphlet was based upon a misconception of the intensity of the forces operating at the outlet of the East Channel.

"In describing the forces available for the purpose of maintaining a channel by tidal currents, the author of the paper has divided them into two principal groups. One, composed of the waters passing through the Narrows; the other, of those from Raritan Bay and its adjacent drainage areas. The report then adds: 'Both of these forces pass seaward between Sandy Hook and Coney Island, being divided by the Dry Romer Shoal, and it is estimated that the quantities of flood-tide waters are almost identical on either side of the shoal, while the ebb-tide waters are from 10 to 15 per cent. stronger over the East Bank and through the channels north than through the channels on the south side of the shoal. It is probable that none of the waters that pass through the Narrows on the ebb tide ever flow south of this shoal, except at the seaward end of the bar, and under special conditions, such as high freshets, or the backing up of the waters by unusual winds.'

"If this statement were true, Sandy Hook would soon be cut down to a short spit, and the main ship channel, instead of having over 67 feet in depth, would become subordinate to the East Channel. Moreover, were there no considerable stream of water flowing south of the west end of the East Channel, there could be no cause for the well-defined valley extending into Sandy Hook Bay. The form of the bottom is such as to contradict most emphatically this statement. There can be no doubt but that a large portion of the discharge passing through the Narrows impinges upon the New Jersey shore of Sandy Hook Bay, is then reflected along the west side of the Hook, and thence deflected to the eastward through the main channel. At the mouth of the East Channel there is a bar at least two miles in length between the 30 feet curves, and having, according to the latest surveys, a least depth of 19.5 feet, requiring the removal of over 4,600,000 cubic yards. To remove this, there is a *surface* resultant of considerable power operating in the direction of the ebb tide, but which, according to Prof. Mitchell, does not extend to a depth of 12 feet, and consequently can have no material effect upon the bottom. At Gedney's Channel, on the contrary, the bar is but ¾ mile in length with a least depth of 23.3 feet and containing only 760,000 cubic yards, whilst the resultant scouring forces extend to below 30 feet at a point just inside of the entrance. All the reports agree in stating that the tidal forces in this channel exceed those of any other locality. Hence, it is believed that, notwithstanding the desirability of improving the shorter route *via* the East Channel, the cost and difficulties of such an undertaking by tidal scour would be so great as probably to render it impracticable, whilst the conditions at the head of Gedney's Channel are exceptionally favorable for such an improvement.

"The limited resources of the engineers having charge of works of this description is shown by the following extract from a report made upon one of the most important ports of entry in the Gulf. 'Deeper water on the bar is needed, and the question to be considered is, how that deep water can be obtained. The methods are two: (1) by dredging alone; (2) by using tidal scour between jetties, aided, if necessary, by dredging. As to the first method, it has already been tried unsuccessfully,' etc.

"From this statement it appears that the element of deflection of surface currents by means of floating deflectors for the purpose of producing bottom scours, does not appear to have entered into the problem; and yet it is believed to be a more important and potent factor than any hitherto considered. It was believed by the speaker that a combination of this principle of vertical deflection, with an increase in the prism of discharge through any given section, by properly arranged lateral wings, would secure the desired depth with a comparatively small expenditure of time and money.

"Copies of old charts of the vicinity of Sandy Hook were also exhibited, extending back over 150 years and showing a minimum depth on the bar of 3.5 fathoms, as well as the phenomenally deep basin at the western end of Gedney's Channel, to which allusion has been made in the Studies recently submitted."

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 23 MURRAY STREET, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, APRIL, 1887.

THE office of the RAILROAD AND ENGINEERING JOURNAL will, on May 1 next, be removed from No. 23 Murray-street to No. 45 Broadway, New-York City. All communications intended for the JOURNAL, its proprietor or its editors, should be addressed to No. 45 Broadway from May 1 next.

THE carefully prepared table which we reprint in another column shows that up to the adjournment of Congress, on March 4, the Navy Department had been authorized to construct ten steel cruisers and fighting vessels of large size, five gunboats, one dynamite cruiser and one torpedo boat, and also to complete the five double-turreted monitors which have for years been in an unfinished condition. This will give the Navy a total of 22 vessels built and armed in accordance with modern practice, four of which are already in commission or will shortly be so. The total amount appropriated for these vessels has been $31,000,000, a very respectable sum, and in addition the amount of $2,150,000 has been appropriated for torpedoes and for special vessels for harbor defense.

There is no doubt that the judicious expenditure of the appropriations will be of great service in giving the country the beginning or foundation of a navy worthy of its reputation and standing, and armed in accordance with modern ideas.

THE Army did not fare so well as the Navy in the late Congress, the Fortification bill having failed in the hurry of the close of the session. Little or nothing can therefore be done in the way of new forts or armament during the present year, but there will doubtless be much discussion over the many plans proposed. The old gun-and-armor controversy continues active, and arguments have been brought up on both sides of the question, although it would seem that nothing more could be learned by discussion, and that the time had arrived when actual experiment is needed. So much has been done in this line in Europe, however, that such experiments as can be made in this country will add but little to our actual knowledge, except, perhaps, in one direction.

THE use of the Rodman gun, or of guns cast on the Rodman plan, substituting steel for the cast-iron originally used, is urged by Mr. William Metcalf, in his paper read before the American Society of Civil Engineers, an abstract of which will be found in another column. Mr. Metcalf is a high authority on all questions relating to steel, and his paper certainly presents a very strong argument in favor of the Rodman gun, as opposed to the "built-up" gun of forged steel—so strong as to make it appear wise to give this system a thorough trial before spending large amounts in turning out guns on the more expensive plan which has found favor in Europe.

THE execution of the Interstate Commerce bill is to be entrusted to a board composed of lawyers. One of these lawyers, however, has had a large experience in railroad cases and is considered high authority not only on railroad law, but also on questions of traffic and rates. Another has been engaged in important railroad cases, while a third has had four years' experience as head of a State commission under a law which permits very strict regulation of railroads. To obtain the services of a man with practical experience in railroad management and of a standing high enough to command public confidence would have been extremely difficult, if not impossible, and the President has made about the best commission that could have been selected under the circumstances.

IN March, as in February, the meetings of the various railroad clubs were largely occupied in discussing the question of car heating. Not much that was new was brought forward at any of the meetings, the time being largely taken at all by explanations of various systems of heating, either proposed or in actual use. Very little more can be done in an experimental way this season, and the subject will go over to next winter, when, probably, the interest in it will be less active than now, lacking the stimulus given by the terrible accidents of the past winter.

A VERY common opinion seems to have been pretty accurately summed up by Mr. Lauder at the New York meeting, when he expressed his belief that "continuous heating" was bound to become as general in its application to passenger trains as continuous brakes. He had not yet seen his way clear to the adoption of any of the proposed systems, but he had very little doubt that one would be devised that would meet all the present objections. The main point which Mr. Lauder urged was the adoption of a uniform coupling which should make it possible to exchange passenger cars without interfering with the heating arrangements.

Mr. Forsythe, speaking in Chicago at almost the same time, expressed views very nearly identical with those of Mr. Lauder, and, like him, expressed pretty accurately a general current of opinion.

THE use of electric motors for light machinery in towns and cities, where power can be transmitted from a central station, presents a very promising field for the future. There is a large and increasing demand for power in nearly

all our cities, and if the electricians can meet this demand by motors which are easily controlled, safe and not too expensive, there is no doubt that they have a great opportunity. A paper read at the Electric Light convention in Philadelphia by Mr. Sprague called out much discussion and much interest among electrical engineers. The use of electricity in transmitting power is still in the first stages of development, and much is to be expected from it in this direction.

THE EFFECT OF COLD ON RAILROAD AXLES.

THAT cold makes iron and steel brittle is the general opinion of people who have more practical experience than scientific knowledge. But notwithstanding this popular impression the experiments which have been made by scientists show very contradictory results. Some of them assert that "the absolute or tensile strength of iron and steel is not diminished by cold," and Dr. Poule, after making a series of experiments, concluded that "frost does not make either iron (cast or wrought) or steel brittle." Other investigators have, however, reached quite different conclusions. But the common experience of practical men and scientific investigation both indicate that when iron or steel is at a very low temperature the effect of transverse sudden impact is very different from that of a steady tensile strain, and that when such metal is warm it is less liable to fracture by a sudden blow than when it is cold. To throw some light on this important subject Mr. Thomas Andrews made a series of experiments with full-sized railway "carriage" axles, manufactured at the Wortley Iron Works. These axles were made from clean selected scrap iron. Forty-two complete axles were tested, and the results of his researches are given in a paper published by the Institute of Civil Engineers. The axles were tested by the impact of a falling weight of 2,240 lbs. Two tanks were arranged so that some of the axles were immersed in a freezing mixture in the one tank, and others were placed in a warm-water bath in the other tank. Great care was taken to ascertain the temperatures of the axles that were tested. After being immersed in the freezing mixture or the warm bath they were carefully adjusted in the supports—3 ft. 6 in. apart—of the testing apparatus. The ball, or test weight, was then allowed to fall on the center of the axle from the elevation recorded. The axle was then re-immersed in one of the tanks, and again withdrawn and placed in the testing apparatus, receiving another blow from the ball, but in a reverse direction from the first, as the axles in each case were half turned over after every blow. In the first set of experiments one axle, tested at a temperature of from 7° to 10° Fahrenheit, broke after the third blow of the weight falling 10 ft., and another broke after the second blow. Three others were similarly tested at a temperature of 212°. They broke after the fifth, seventh and thirteenth blows respectively.

In another series of tests the axles were subjected to the blows of the weight falling 15 ft. Two of them also were at a temperature of 7° and two at 120°. The cold axles both broke after the second blow, and one of the warm ones broke after the third, and the other after the fifth blow.

A third series of tests was made with some axles at a temperature of from 7° to 10° and others at 100°, with the weight falling 10 ft. For convenience of comparison the three series of tests are tabulated below:

FIRST SET OF TESTS, WEIGHT FALLING 10 FEET.

COLD TESTS.		WARM TESTS.	
TEMPERATURE OF AXLE 7° to 10°.		TEMPERATURE OF AXLE 212°	
Axle No. 2	3 Blows.	Axle No. 4	5 Blows.
" " 12	2 "	" " 5	7 "
		" " 7	13 "

SECOND SET OF TESTS, WEIGHT FALLING 15 FEET.

TEMPERATURE OF AXLE 7° to 10°.		TEMPERATURE OF AXLE 120°.	
Axle No. 8	2 Blows.	Axle No. 10	3 Blows.
" " 9	2 "	" " 11	5 "

THIRD SET OF TESTS, WEIGHT FALLING 10 FEET.

TEMPERATURE OF AXLE 7° to 10°.		TEMPERATURE OF AXLE 100°	
Axle No. 15	6 Blows.	Axle No. 14	5 Blows.
" " 16	9 "	" " 17	6 "
" " 18	3 "	" " 20	3 "
" " 19	6 "	" " 21	5 "
" " 22	1 "	" " 13	6 "
" " 24	4 "	" " 25	10 "
" " 26	4 "	" " 27	11 "
" " 28	4 "	" " 31	8 "
" " 29	12 "	" " 32	12 "
" " 30	6 "	" " 33	9 "

FOURTH SET OF TESTS, WEIGHT FALLING 10 FEET.

TEMPERATURE OF AXLE 7°.		TEMPERATURE OF AXLE 100°.	
Axle No. 3	23 Blows.	Axle No. 13	19 Blows.
" " 6	34 "		

With reference to these experiments the author of this paper says: "It will be noticed that Nos. 15, 16, 19 and 29 of the cold tests appeared exceptional to the general principle, enduring a greater total mean force before destruction than the axles in the warm tests of this set. The respective halves, therefore, of each of these axles, were turned down to 4½ inches diameter throughout and again tested, the one half at a temperature of 10° F., and the other at 100° F., but otherwise under the equal conditions employed in case of these axles when whole." In the second tests the warm half in each case had very much greater resistance than the cold half, of which the author says: "From this it will be seen that the results were confirmatory of the rule; the apparent deviation from the general uniformity was possibly due to some molecular difference in the material composing the several axles."

Of the fourth set of tests the experimenter remarks that, "Although these axles afforded exceptions to the general principle, yet when the halves of each axle were again tested respectively at 7° and 100°, the warm axles stood considerably more than the cold."

While the preponderance of evidence furnished by the above experiments indicates that the warm axles had greater power of resisting the blows to which they were subjected than the cold ones had, yet the results are not at all conclusive. To explain a deviation of the behavior of some axles from the others by saying that it "was possibly due to some molecular difference in the material composing the several axles" is, in substance, saying that the tests proved what the experimenter did not expect or want them to prove. If the greater power of endurance of some of the cold axles is "due to some molecular difference," then it is of the utmost importance to find out the real nature and cause of that difference, and, if possible, learn how to make axles having a molecular structure which will give such an increased power of resistance. It may be, and probably is, true that one kind of material

will resist blows better when cold than when it is warm, while another quality might stand more at a high temperature than at a low one.

Furthermore it may be that a cold axle, of a given quality, will resist light blows better than a warm one, whereas the reverse might be true if the blows were heavy. It is said to be a well-known fact, that steam-hammer piston-rods, made of hard steel, will stand many times longer than soft steel; whereas, if they were subjected to transverse destructive blows, similar to those with which the axles were tested, no doubt soft steel would stand more of them than hard steel. The author of the paper quoted from says "that an increase in the extent of the first deflection at the first blow has an influence on the after endurance of an axle, and consequently he is of opinion that in testing axles by impact, the application of a number of lesser impacts is preferable to the extremely heavy test-blows required in the specifications of some railway companies."

An examination of broken journals generally shows that the fracture commences with a circumferential crack at the throat or inside fillet. These cracks appear to extend gradually toward the center of the axle until the amount of solid metal which remains is not sufficient to hold up the load on it. How long it takes for such fracture to extend from the surface inward is probably not known, but it appears certain that what should be aimed at is to prevent the initial fracture at the surface and it may well be that a hard and comparatively brittle material will do this better than one which is soft and ductile, while, at the same time the former would stand fewer destructive blows than the latter.

All that the experiments of Mr. Andrews seem to prove is, that with the special quality of axles which he tested, most of the warm ones stood more destructive blows than the cold ones did. What the result would be if the test-blows were lighter or the material different, it remains for future experiments to determine.

THE BUSSEY BRIDGE ACCIDENT.

AFTER a great calamity like that which happened in the Boston & Providence Railroad, from the failure of a bridge on March 14, there is always a great deal of very loud interrogation about the cause of the accident, and the responsibility for its occurrence. No doubt the official investigation of the Railroad Commissioners will show the origin of the disaster, and fix the blame where it belongs, so that it will hardly be worth while to say anything now about the construction of the bridge, especially as all the facts relating to it will probably be brought out more fully and accurately by the official investigation than they have been by the newspapers or can be by any casual inspection. The fact that the bridge broke down is incontrovertible evidence of defective construction. The question then naturally arises, were the defects discoverable, and if so, why was it permitted to remain in service? The Boston & Providence Railroad is a rich corporation, abundantly able, financially, to have all its equipment of the very best kind. Its list of officers, however, does not show nor has it appeared in the public discussion that a competent engineer is employed by the Company. This probably means that the responsibility for the condition of the bridges on its road, has not been delegated to a person with the ability and experience required to discover defects in their design and construction. This is not unusual, and the importance of competent engineering ability, in the management of railroads is either partially or entirely ignored. Directors and traffic managers are generally persons who have had an exclusively mercantile training, the value and importance of which is not questioned. But those who have been educated exclusively in the school of barter very often have a defective appreciation of the inexorable character of physical laws. Somehow or other that kind of people often find it difficult to rid themselves of a secret, lurking feeling that by skillful finesse they can "corner" the laws of nature. This is often amusingly illustrated by the way new inventions are "promoted" in Wall Street and its precincts. Those who engage in such projects sometimes seem to regard the scientific principles on which the invention depends, as a mere incident which can always be twisted to suit their purposes by a hired expert. In the same way, successful grocers and "bankers" feel, that by dispensing with the services of an engineer, at a fair salary, and delegating his duties to a "gang boss," that they can "beat" the law of gravitation and the principles of statics. These often take their revenge, as they did on the Boston & Providence Railroad, and as they have done and will do in other like cases.

Another very common evil is that of depriving the persons in charge of the engineering departments of railroads of the authority which they should have if their responsibility is more than a mere name. It is of course true that the business of a railroad is to carry freight and passengers, and to get pay for it, and that the financial and traffic departments should be conducted with reference to earning reasonable dividends, and further, that this conduct requires a special kind of ability, knowledge and experience quite different from that needed to construct and maintain a railroad and its equipment so as to give the maximum efficiency. But because this is the case, it does not follow that those in charge of the permanent works or machinery should be made subordinate to the traffic or the accounting departments, as they often are There must be a commander-in-chief of some kind of every railroad, with deputies below him. What is advocated here is that there should be, on every railroad, a competent deputy in charge of the permanent engineering works of the road and another in charge of the machinery and rolling stock, and that these deputies should have coördinate authority and power with those in charge of the other departments. If there had been a competent person entrusted with the responsibility of the bridges on the Boston & Providence Railroad, with no authority over him excepting that of the commander-in-chief and his council, it is not probable that such a structure, as the Bussey bridge evidently was, would have been allowed to remain in service. The failure of the Glens Falls bridge on one of the Delaware & Hudson Canal Company's leased lines in 1883, and that at Scottsville on the Buffalo, New York & Philadelphia Railroad, in the same year, were due to this same lack of responsibility. In their report on the former accident, the Railroad Commissioners of New York said: "The Board also censures the management of the Delaware & Hudson Canal Company, specifically for failing to have the bridges and trestles on its lines of roads properly tested and examined. Through the absence of such examination under a well-regulated system this disaster occurred. For divided responsibilities

and incompetency in the performance of their duties by subordinates, such as is here disclosed, a railroad corporation is primarily and legally responsible."

Drawing-Room Car-Seats.

THE experiment is now being tried on the Boston & Albany Railroad of substituting some of M. N. Forney's double seats for chairs in the drawing-room cars. A few of these seats have been put into several of the cars, which are now running in the trains which leave Boston and New York daily at 4.30 P. M. For the same price that is now paid for a single chair, the passenger will be entitled to the exclusive use of one of these seats. The chief attraction of drawing-room cars for passengers is their exclusiveness; that is, persons by paying for it can secure a seat to themselves. It is not intended to take that feature away from these cars by the introduction of the "sofa seats," as they are called, which have all the elements of comfort that chairs have. The latter are, however, limited in size, and do not allow of much change of position to those who occupy them, whereas the "sofa seats" give double the space, and occupy no more room lengthwise in the car than the chairs do, so that the railroad company can afford to give the privilege of occupying the one at the same price that is charged for the other. The double seat, if occupied by one person, gives sufficient room to permit of more change of position than is possible in a chair; and it also gives space for books, baggage or parcels. Revolving chairs always create a liability of trespass by neighboring passengers on each other's territory, which, to ladies, is often unpleasant, not to use a stronger term. Double seats with reversible backs also have the advantage that they allow passengers to sit much nearer to the windows than is possible in revolving chairs. Consequently the person in the seat has a much wider range of vision when looking out of the window than he has when sitting in a chair, which must be placed some distance from the side of the car so as to have room to turn.

As mentioned above the sofa seats have been put into the cars referred to as an experiment; that is, to determine whether they will be popular with passengers.

NEW PUBLICATIONS.

THE ROMANCE OF INVENTION.—BY JAMES BURNLEY. Cassell & Co. (Limited), London, Paris, New-York and Melbourne.

IN this book, as the author says in the opening sentence of his preface, "Some of the more romantic features of the history of invention have been described, apart from their technical surroundings." The book covers a wide range of subjects beginning with inventions in prehistoric ages, and a chapter on the dreams of the alchemists, and another on the martyrs of invention. The description of the persecutions of inventors in the "good old times," when people were beheaded and tortured because they happened to think differently from their neighbors, gives a picture of society which at the present day seems to be quite impossible. One of the most interesting chapters in the book is that relating to the phantoms of inventors. The chapter relating to the inventions of persons for secret murder, gives an insight into one of the darkest phases of human nature, which now, happily, has nearly or quite disappeared. The title of the book would perhaps give the impression that it treated of invention in the arts, to which the term is generally applied. Instead of that the author has burrowed into all kinds of curious places, and he shows the many and varied channels in which human ingenuity has been employed. Castles in the air; Inventors in Love; Poverty of Inventors; Fashion; Royal and Noble Inventors; Inventions of Punishment: of Costly Machinery; of Toys; Inventors on the Sea; Amongst the Wires; Discoveries by Accident; of Wheels; of Weapons; of Cooks; of Music: in Fire and Smoke; and Books and Literature—are the titles of different chapters.

The book is written in a popular style, and contains much curious information. The probabilities are, though, that a careful study of the lives of many inventors would reveal much more thrilling romance than any which the author has collected in his somewhat discursive chapters. If it were possible to discern and reveal the dreams, the hopes, the disappointment and often the despair of those whose expectations are centered in the Patent Office, it would make a picture more romantic, more pathetic, and often more tragic than any of the chapters in the book before us.

BOOKS RECEIVED.

SHOPPELL'S MODERN HOUSES. *Number 5.* Published at 191 Broadway, New York. Containing designs for houses and other buildings.

UNITED STATES GEOLOGICAL SURVEY—MINERAL RESOURCES OF THE UNITED STATES, 1885. Washington: Government Printing Office.

INTERNAL COMMERCE OF THE UNITED STATES, 1886. Washington: Government Printing Office. This is Part 2 of the Report on Commerce and Navigation, prepared by Wm. F. Switzler, Chief of the Bureau of Statistics. It contains elaborate reports on the productions and trade of a number of Southern States, and some valuable statistics of Southern railroad traffic.

MISURE DI VELOCITA NEL TEVERE. Paper by Professor Ildelbrando Nazzini. Published by the Royal School of Engineers, Rome, Italy.

ANNUARIO; SCUOLA D'APPLICAZIONE PER GL'INGEGNERI, 1886-87. This includes the programme and announcement of the Royal School of Engineers, which is a department of the University of Rome; also catalogues of the library, etc. Italian engineers are taking high position in Europe, and the faculty of the School includes several distinguished names.

THE KINDS AND GRADES OF BELTING TO USE FOR DIFFERENT KINDS OF WORK. The Page Belting Company, Concord, N. H. This pamphlet contains a number of practical rules and directions for the purchase and use of belting, which will be very convenient for the use of millwrights and others.

REPORT OF THE REGENTS' BOUNDARY COMMISSION UPON THE NEW-YORK AND PENNSYLVANIA BOUNDARY, WITH THE FINAL REPORT OF MAJOR H. W. CLARKE, C. E., SURVEYOR FOR THE COMMISSION. Albany: Weed, Parsons & Co.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE, 1886, VOLS. I. AND II. E. & F. N. Spon, London and New York.

OBITUARY.

MR. ESTUS LAMB, for many years a prominent manufacturer, died in Providence, R. I., March 9, aged 77 years. Mr. Lamb was half owner of the large cotton mills at Putnam, Conn., and was interested in many other enterprises. He had been for 25 years a director of the Providence & Worcester Railroad Company, and President of the company for three years past.

LIEUTENANT JOSEPH S. POWELL, of the U. S. Signal Corps, died at his residence in Washington, March 14, of softening of the brain. He had just returned from Omaha. Lieutenant Powell ranked third among the Signal Service lieutenants, according to seniority, and was the first officer appointed after competitive examination. He had a particular aptitude for indications work, and, as he was naturally bright, he made the best record on indications of any officer who has ever done the work. A few months ago he was sent to Omaha to take charge of the organization of a weather bureau for the Union Pacific Railroad.

COMMANDER EDWARD P. LULL, United States Navy, died at the naval station at Pensacola, March 5, at the age of 51 years. He was a native of Vermont, and in 1851 was appointed to the Naval Academy from Wisconsin. He was graduated in 1855, and up to the outbreak of the War he served on the *Congress* in the Mediterranean, and on the *Roanoke* of the home squadron, becoming master in 1858, and a lieutenant in 1860. He took part in the attack which the *Roanoke*, a steam frigate, made on the rebel forts at Hatteras Inlet in July, 1861, and in 1862 and 1863 was on duty at the Naval Academy. In 1862 he was commissioned lieutenant commander, and in the summer of 1864, on board the famous steamer *Brooklyn* of Farragut's busy fleet, he participated in the battle of Mobile Bay. He was honored by the command of the captured iron-clad *Tennessee*, which was attached to the Mississippi squadron, and joined in the bombardment of Fort Morgan in August, 1864. In 1866 he was on the *Swatara* of the West India squadron, and from 1867 to 1869 was at the Naval Academy. In 1870 he was commissioned commander, and in the following year commanded the store-ship *Guard*. In 1872 he was employed in the Bureau of Yards and Docks, in 1873, and '74 at the torpedo station, and in the two years following was Hydrographic Inspector of the Coast Survey.

HON. EDWARD BREITUNG, one of the pioneers in developing the iron mines of the Lake Superior Region, died at Eastman, Ga., March 3, aged 56 years. He was born and educated in Saxe-Meiningen, Germany, but came to this country when 19 years old, and settled in Detroit, Mich. In 1855 he went to the Lake Superior Region and opened a store in Marquette, then only a village. Soon after this he commenced exploring and buying and selling mineral lands. He remained in Marquette for four years, and in 1859 went to Negaunee, where he has since resided. Here he engaged in mercantile business, and also associated himself with Israel B. Case, and they ran the Pioneer Furnace under contract. In 1864 he sold out his business, and gave his entire attention to mining and mining interests. During the winter of 1864-1865 he began to open up and develop the Washington Mine, and in 1870 he began to open up the Negaunee hematite range. No one believed he would find merchantable ore there, and all thought the venture a foolish one. But he had confidence in his own judgment, and future developments have fully proved that it was sound. In the fall of 1871 he began to develop the famous Republic Mine. In 1873 he commenced explorations on the Menominee Range and continued them for three years. Here again everybody believed that he had embarked in a profitless venture, but, as before, the issue verified the correctness of his opinion. The immense amount of ore taken out of the mines on that range fully justifies the faith he had in that section of the Lake Superior iron field. In 1882 and 1883 he became interested in the Vermilion Iron Range, in Minnesota, where once again the investment that he made proved highly profitable. Mr. Breitung leaves a large fortune, the result of his successful mining ventures. He represented the Marquette District in Congress for four years.

CAPTAIN JAMES BUCHANAN EADS died at Nassau, New Providence, March 8, aged 66 years. He had been ill for some time, and had gone to Nassau with the hope of improving his health, but an attack of pneumonia added to the complications of his disease and carried him suddenly away.

Captain Eads was a native of Lawrenceburg, Ind., where he was born on May 23, 1820. He early evinced a love of mechanics, and when 8 years old watched with the greatest interest all machinery to which he had access. At the age of 10 his father, who had removed to Louisville, fitted him up a workshop of his own, and the boy constructed models of saw mills, fire engines, steamboats and other machines. In 1833 the family removed to St. Louis, but were reduced to poverty by the burning of the steamboat on which the father's property had been shipped. Young Eads began life in St. Louis by selling apples on the street, but soon obtained a place as clerk in a store, and in 1839 he secured a position as purser of a Mississippi steamboat. While acting in this capacity he took every opportunity to pursue his mechanical studies and to acquire a complete knowledge of the great river, which he was afterward to turn to so good an account.

In 1842 Captain Eads constructed a diving-bell boat to recover the cargoes of sunken steamers. It was his first invention of practical benefit, and was soon followed by a boat of larger tonnage, provided with machinery for pumping out the sand and water of sunken vessels, and lifting the entire hull and cargo. A company was formed to utilize this invention, and many valuable steamers were raised and floated by this method. It was while engaged in this wrecking business that he gained a thorough knowledge of the laws which control the flow of silt-bearing rivers, and he was able to say of the Mississippi a few years afterward, that there was not a stretch in its bed 50 miles long, between St. Louis and New Orleans, in which he had not stood on the bottom of the stream beneath the shelter of a diving bell. In 1845 he sold his interest in this company and established in St. Louis the first glass-ware manufactory west of the Ohio River. This enterprise failed, and he returned to the business of raising steamers, removing obstructions from the channel, and improving the harbor of St. Louis, a business which in the next ten years produced him a fortune of some half a million dollars.

In 1856 Mr. Eads made a proposition to Congress to keep the channels of the Mississippi, Missouri, Ohio and Arkansas rivers free of snags, wrecks and other obstructions, but his plan failed for want of action by the Senate. His work on this plan, however, was not forgotten, and early in the war, when it was decided that operations in the West must follow the line of the Mississippi, he was asked to prepare plans for gunboats to be used on that river and its tributaries. He designed seven iron-clad gunboats and took a contract to build them, completing the work in a little over two months, near the end of 1861. In 1862 he was commissioned to build six more armored iron gunboats, four of which were much larger than any of the preceding ones. While these were under way he also had the construction of four heavy mortar boats and seven "tin-clad" or musket-proof boats. The good service which these vessels did during the war in assisting the operations of the Army in securing control of the river is a matter of history.

After the close of the war, Captain Eads undertook the construction of the great bridge over the Mississippi at St. Louis. This bridge, with its central steel arch of 525 ft. span, and the side arches of 502 ft. each, has often been described, and much has been written of the difficulties encountered in the erection of its piers, and in the sinking of the caissons on which they stand. It was finally completed and opened for traffic July 4, 1874, nearly seven years after the work was first begun.

Upon the completion of the St. Louis Bridge, he

began to press his plans for deepening the mouth of the Mississippi by jetties, a plan in which he was opposed by nearly all the United States engineers, a commission of seven having reported strongly against it. This commission proposed to avoid the bars by constructing a canal from Fort St. Philip to Breton Bay. Mr. Eads' plan was to make the river itself deepen a channel through the bars, and he offered to do the work at his own expense, and wait for his pay until he demonstrated its success. He finally secured permission on those conditions to attempt the improvement of the South Pass, the smallest of the three, the depth on the bar of which was only 8 ft. Captain Eads at once began the work of contracting the width of the current by means of jetties, thus increasing its rapidity and power of wearing away its bed. In four years the success of the jetty system had been demonstrated, a maximum depth of 30 ft. having been secured throughout the jetty channel. Mr. Eads was paid the sum agreed upon by the Government, $5,125,000 in all, part of which had been paid in instalments. The current of the river has maintained its depth ever since, and the cost of the jetties was about half that estimated for the construction of the proposed canal.

Besides these works, Mr. Eads, at the request of the governments and individuals particularly interested, examined and reported upon the bar at the mouth of the St. John's River, Florida, the improvement of the Sacramento River, the improvement of the harbor of Toronto, the improvement of the port of Vera Cruz, the improvement of the harbor of Tampico, the improvement of the harbor of Galveston, and the estuary and port of the Mersey, England. He was President of the St. Louis Academy of Scienee for two terms, and made an inaugural address in which was embodied a review of the recent achievements of science, and, in another, the present knowledge of the laws of light. In 1881 he made an extemporary address before the British Association at York upon the improvement of the Mississippi, and also upon the Tehuantepec Ship Canal which were, by unanimous vote, ordered to be embodied in its report of the proceedings, and in June, 1881, he was awarded the Albert Medal of the British Society of Arts, in token of its appreciation of the services he had rendered to the science of engineering—he being the first American upon whom this medal had been conferred. He was also for a year Vice-President of the American Society of Civil Engineers.

Captain Eads was not a man to rest quietly on the reputation of his past successes, however, and he soon became interested in a new project, the construction of a ship railroad from the Atlantic to the Pacific, across the Isthmus of Tehuantepec. He spent much time in demonstrating the practicability of his plan, by which ships were to be transported across in cars, loaded in cribs made especially for the purpose. He argued that such a railroad could be built wherever a canal could, at one-half the cost of the canal with locks, or one-quarter the cost of one at tide-level. He claimed that a ship railroad could be maintained for less than a canal, and that his plan, if carried out would, both by its method and location, be of greater service to commerce than either the Panama or the Nicaragua canals.

Captain Eads obtained a concession for the building of his ship railroad from the Mexican Government, and secured the organization of a company. He was, however, unsuccessful in his attempts to persuade the United States Government to undertake the work or to guarantee interest on its cost. A bill to incorporate this company passed the United States Senate during the session just closed, but failed to pass the House.

Captain Eads was married in 1845 to Martha N. Dillon, daughter of Patrick M. Dillon, of St. Louis. His wife died in 1852. He was again married to Mrs. Eunice S. Eads, who survives him. He had five daughters, three of whom married, respectively, John A. Ubsdell, of New York; Estil McHenry, Assistant Postmaster, of St. Louis, and James F. Howe, of St. Louis, Secretary and Treasurer of the Wabash Western Company. Capt. Eads was granted the degree of LL.D. by the Missouri State University. He was identified with St. Louis business from the time of his arrival there as a boy, and always considered himself a citizen of that city, although his Tehuantepec project had led him to spend much time in the East for two or three years past.

Contributions.

Mason and Dixon's Line.

Editor of the Railroad and Engineering Journal:

IN the opening paragraph of your article upon Geodetic Work in the United States, in your March issue, I think you somewhat mistake the popular idea of Mason and Dixon's Line—that it "was the northern limit of slavery established by the Missouri Compromise in 1820." The popular belief was that this line was the northern limit of slavery east of the Ohio River, which was in accordance with the facts, so far as Mason and Dixon's Line forms the south boundary of Pennsylvania. It was known as such before the days of the Missouri Compromise, and was fixed in the public mind and made historical by the political speeches of that fervid period.

As a matter of professional interest, I will state that the original Field-book and Journal of Mason and Dixon is deposited in the library of the Pennsylvania Historical Society in Pennsylvania in Philadelphia. It is a volume of foolscap of over 300 pages, and contains all their notes and computations. Each page is signed by both astronomers.

H. W. CLARK.

SYRACUSE, March 5, 1887.

The Forney Car-Seat.

To the Editor of the Railroad and Engineering Journal:

Your last issue contains a description and illustration of the "Forney car seat," and claiming for it merits over the ordinary car seats. The "Forney seat" is undoubtedly more comfortable than the ordinary car seat, but the "Forney back" is far from comfortable. I have sat in the Forney seats many hours, riding on the New York Central Railroad, and found the concavely shaped backs so tormenting that I prefer an ordinary car seat. For hunchbacked, or old, stooping persons the "Forney back" may do; but not for a naturally straight spine. I believe that the back should neither be concave nor convex, but it should be straight, properly inclined, and not so high as to compel taking off one's hat. I have heard the same complaint from other travelers with straight spines.

TRAVELER.

[The criticism of "Traveler" of the seats referred to is, to some extent, a just one. In designing them the mistake was made of giving the backs *too much* curvature. This defect has been remedied in seats made since those referred to were put in the New York Central cars, and the same change can easily be made in them by a little alteration of the upholstering. To make the backs straight, as proposed, would, however, defeat one of the objects aimed at in this form of seat, which is to give support to the lumbar region of the backs of passengers. The backs of all drawing-room car chairs and seats in sleeping cars are now made curved, and in European railway carriages that form is universally adopted.

There is a very great difference of opinion with reference to the most comfortable length for the backs of car

seats. In drawing-room and sleeping cars high backs are now universally demanded, whereas some passengers, like our correspondent, object to them in ordinary cars. Probably for local travel low backs are preferable ; but for long journeys a support for a passenger's head is certainly very grateful.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

THE GEODETIC WORK IN THE UNITED STATES.

II.—BORDEN'S SURVEY OF MASSACHUSETTS.

BY PROF. J. HOWARD GORE.

WHILE the primary object of this survey was simply to secure an accurate map of Massachusetts, the trigonometric part of it was so elaborately conceived and so carefully executed that the results have been regarded as suitable for geodetic data. This work was the carrying out of two resolves of the General Court of Massachusetts during the session of 1829-30, one requiring each town in the Commonwealth to forward to the office of the Secretary of State accurate maps of its territory on a scale of 100 rods to an inch, and the other empowering the Governor to appoint a surveyor with assistants to make a trigonometrical survey of the State, accompanied by astronomical observations.

Robert Treat Paine, of Boston, was selected Chief Engineer with Mr. Stevens, of Newport, as Assistant, and Simeon Borden was ordered to repair the instruments loaned by the United States Coast Survey, and to construct the base apparatus.

The astronomical observations and transfer of chronometers for the determination of differences of longitude were commenced by Mr. Paine in the spring of 1831, together with the triangulation by Mr. Stevens, assisted by Borden. In 1834 Stevens resigned, when the trigonometric work fell to Borden, and in 1838 Paine retired, after which Borden was placed in charge of the entire survey, a position he held until its completion.

The base apparatus was modeled somewhat after the one first used by Colby, in 1827, in the measurement of the Lough Foyle base. It was 50 ft. long, consisting of two rods ⅜ in. in diameter, one of steel and the other of brass. Each rod was composed of four nearly equal parts, joined end to end by coupling boxes so made that the ends of two parts could be brought into perfect contact and held in that position. The attachments of the rods were of the same metal as the rods themselves. They were supported within a tin tnbe, larger in the middle than at the ends, by nineteen cast-iron stirrups, each of which was secured by five screws to keep them in a single plane and the rods straight when in place. Near the center of each sheet of tin forming the tube was soldered a flange of tin 1 in. deep, which served to strengthen the tube and prevent it from collapsing while in use; the supports were placed near these flanges. The tube was 49 ft. long, the four pieces of which it was made being attached to one another by small screw-bolts passing through strong brass flanges that were fastened to the end of each section. These flanges were of sufficient strength and size to allow the two end ones to serve as bearings to rest in the Y's of the trestles. The ends of the tube were closed with cast iron pieces with holes in them, through which the rods passed. To the ends of the rods transverse arms were attached ; one end of each arm carried a small silver disc with cross-lines on its horizontal face, the intersections of the lines marking the ends of the measure. By making the distances from this intersection to the attachment to each of the rods proportional to the coefficient of expansion of each, the intersection should remain invariable at all temperatures—a principle beautiful in theory but unsatisfactory in practice. The failure of this principle, known as that of compensation, may be owing to uncertainties in the assumed coefficients of the particular rods in use, the inconstancy of the adopted coefficient, ignorance as to the results of molecular change during fluctuations of temperature, or to mechanical inability to correctly secure the proper ratio of the lever arms.

The tube was supported upon two tripods, carefully and substantially made, the heads having horizontal and vertical motions, by means of thumb-screws. The microscopes were compound with a focal length of 1⅝ in.; these were provided with trestles similar to the others. The line, situated in the Connecticut Valley above Northampton, was aligned, using for the purpose the theodolite that was afterward employed in placing the tubes in line during the measurement.

The termini of the base were marked with cross-lines upon copper bolts of about ¾ in. in diameter; these were driven firmly into holes drilled for the purpose in large stones, and imbedded in the earth about 18 in. beneath the surface.

In measuring, the cross-wire of one of the microscopes was adjusted over the mark on one of the terminal monuments ; the tube was then put on the trestles previously placed in position and moved laterally until in line, and longitudinally until the mark on the disc attached to one end of the rods was in coincidence with the cross-wires of the microscope. The other microscope was then adjusted directly over the disc on the forward end, after which the tube was carried forward and so placed that the rear end would be under the second microscope, and so on, the whole work requiring the services of eight men. The inclination and number of tubes were recorded. Under the intersection of the cross-wires of the microscope that marked the last of each 20 tubes, a piece of brass wire was put in a wooden plug driven in the ground. The end of each day's work was similarly fixed.

The line was measured twice and the differences in the distances between each pair of marks were noted ; the maximum difference was 0.828 in. and the minimum 0.02 in., with 3.523 in. as the sum, while, after correcting for inclination, the difference in the two measures was only 0.237 in., or 1 : 1,975,176 in a line 39,009.73 ft., or 7.3882 miles long, when reduced to sea-level and referred to Hassler's 82 in. Troughton scale at 62° F. The elevation above sea level was found trigonometrically, giving the northern end 49.55 ft. higher than the southern, while, by computing the difference in the height of the two ends of each tube from its known length and the observed inclination, and taking the algebraic sum of these differences, the northern end was 50.43 ft. higher than the southern end. The latitude and longitude of both ends of the base were carefully determined, the former from a large number of observations on circumpolar stars, and the latter by transfers of chronometers.

In the triangulation a repeating theodolite with a 12 in. circle and telescope of 46 in. focal-length was used.

While observing. the instrument was protected by a circular tent having the upper portion of each side provided with flaps, so as to be opened or closed when necessary. Artificial signals were built at every station; these consisted of tripods with a center-pole pivoted at the point of attachment to the tripod. In some cases these center-poles were as much as 80 ft. high, when it was found necessary to guy them with wire in four directions. To make the signal visible at a great distance a very ingenious device was adopted. A bag with both ends open, made of cotton, was kept inflated by having sewn within it two barrel hoops; the whole was placed around the center-pole, the ends gathered in and firmly attached to the pole. This may have suggested the barrel that was afterward used by the Coast Survey on reconnoissance and secondary triangulation. The center of the station was marked like the ends of the base, its position having been determined by the aid of two transits placed approximately at right angles to one another. When a station was occupied the center-pole was tilted over, so that the lower end would be out of the way, and the observing tent suspended from the tripod.

The time spent at each station varied from one to twelve days, care being taken to observe, as far as possible, at times when the atmosphere and underlying earth between the observing and observed stations were nearly of the same temperature. Azimuth observations were made at two points within each section 50 miles square. The formulæ used in computing geographical positions were those of Oriani, involving an "elliptic spheroid," first published in 1821.

He computed the lengths of eight meridional arcs, and from each deduced the length of a degree; this varied from 364,336.76 ft. to 364,447.68 ft., with a mean of 364,392 ft. in lat. 42° 4′ 2.48″, or 364,356 ft. in lat. 42° 21′ 40″, which is the latitude of the State House. He also took the longitude of the State House for an initial point, and computed the value of a degree perpendicular to a meridian. In this Paine's longitude determinations were used, and in computing a relative weight, proportional to the polar angle subtended, was given to each arc employed, resulting in 365,747 ft. for a degree as the mean of 10 arcs.

With the data so obtained he determined the earth's elements, which, by comparison with those now quite generally credited, reveal agreements that one could hardly expect when one realizes that this work was done during the infancy of geodesy in this country.

	Borden.	Bessel.	Clarke.
1° of a meridian lat. 42° 21′ 30″ in feet............	364,356	364,403	364,433
1° perpendicular to a meridian 42° 21′ 32″ in feet.	365,724	365,740	365,542
Ellipticity....................................	1:292	1:299	1:293

One is naturally tempted to think that the close agreement between Borden's and Clarke's values is due to chance or accidental compensation of errors, but a crucial test has been applied to Borden's linear measures by the occupation of many of his stations by the Coast and Geodetic Survey, and the subsequent computation of distances that he had determined. The discrepancy between the two results varies from 16 in. to 0.8 in. in a mile, with 6 in. as the mean, or 1 : 10,560; also in the Nantucket arc the Geodetic Survey computed the length of a degree from several small arcs; the nearest mean latitude to Borden's was lat. 41° 36′ 34″, at which point a degree was found to be 364,452 ft., being about 100 ft. longer than Borden's degree at this point. Clarke's spheroid gives for this latitude a degree about 85 ft. longer than Borden found.

We are indebted to Borden for methods rather than for results; his observing tent, signal and care in selecting times for reading angles have became leading features in all geodetic work done in this country since his time. The theodolite with a high supporting standard and repeating angles, copied from the Coast Survey and Ordnance Survey, have long since been abandoned, together with the compensating base apparatus. It has also been found that the flexure in so long a bar would introduce errors of a serious character, so that now we never find an apparatus of more than half the length of Borden's, while many are no more than one-fourth as long.

It is believed that in no country was the first trigonometric geodetic work so successfully performed as was this, America's first contribution.

ROAD BRIDGE OVER THE RIVER TONE AT MAEBASHI, GUMMAKEN, JAPAN.

BY M. OTAGAWA, M. E., TOKYO.

DURING the year 1884, when the main trunk line of railroad through central Japan was to be constructed along the Nakasendo, the Tokyo & Takasaki line was branched to Maebashi, which is the centre of the silk districts in Gummaken, and a road bridge over the River Tone (one of the largest rivers in Japan) had to be constructed at the entrance of the city. Till that time the whole traffic was carried on an old and fragile wooden bridge, a little above the new site, and crossing the river at so low a level that the gradients of the road on both sides were too steep for carriages, and the bridge was often damaged by floods. These inconveniences were much more marked when the railroad reached Maebashi, and caused both the government and people to take some active steps towards the construction of a new bridge. The capital, however, was very limited, being 26,000 yen (about $21,300) for the whole work, including approaches of three-quarters of a mile on both sides of the bridge. Of this fund 15,000 yen came from the local land-tax of Gummaken, and the remaining 11,000 yen was contributed by the inhabitants of Maebashi.

In common with other Japanese rivers in the dry season, the water of the River Tone is very low; but in summer and autumn it is often visited by fearful floods. The bridge site was chosen at the narrowest part of the river, which is best protected in the up-stream by boulders of gigantic size. The very existence of these stones sufficiently proclaims the rapidity of the stream in times of freshets. As there were no people living near the site, information as to the highest flood level could not be obtained, but it was calculated to be 24 ft. above ordinary water level, from the data obtained above and below the site.

The total length of the new bridge is 600 ft., of which 180 ft. consists of two spans of Howe truss in timber; the remaining 420 of 10 spans of beam bridge of the Japanese type with some modifications, each span being 42 ft. The camber of the bridge is 4 ft 3 in., and the width is 24 ft., the formation level being 40 ft. above ordinary water level.

The eastern abutment is brickwork on a concrete foundation, and the western is rubble work on a foundation of piles. There are two cast-iron piers and 10 wooden ones. The river piers are each formed of two columns, placed 22 ft. 7 in. apart from center to center. These columns are composed of cast-iron cylinders, the metal being ¾ in. thick, and are 3 ft. in diameter and in 6-ft. lengths, jointed by 12 1-in. bolts through inside flanges. For 12 ft. at the base the cylinders are 4 ft. in diameter. These columns are filled with concrete and firmly braced.

The superstructure is formed of Howe timber truss continuous over two spans. The truss is 7 ft. 3 in. high between the centers of the booms, which are 16 × 12 in. The span is 90 ft., and is divided into 20 bays, each 4 ft. 6 in. The cross-girders, 12 × 9½ in., are placed on the bottom booms of the truss at intervals of 4 ft. 6 in. The joists, 6 in. square (and 6 × 10 in. at center where planks are jointed), are placed in five rows upon the cross-girders. Upon these timbers is laid transversely 3½ in. planking. These two spans extend over 180 ft.

For the remaining 420 ft., for which the bed is dry in ordinary weather, a simple though less satisfactory design had to suffice, as the funds were so limited; so that the beam bridge was constructed. Here the piers consist of five wooden piles of 15 in. diameter, with butt ends braced and stiffened by crib-work at the bottom. The cantilever beams and longitudinal stringers, 16 in. square, are placed in five rows upon the cross-beams of the pier. Upon the stringers there is laid transversely 3½ in. planking. The parapet railing for this part of the bridge consists of castings with wooden posts fixed to the exterior stringers at intervals of 6 ft.

For the purpose of facilitating the transportation of the building materials to the bridge-site, and giving accommodation to the public, the road on one side from the railroad station and on the other from the southwestern corner of the city of Moebashi to the bridge was constructed, and a temporary pontoon bridge made a little below the site. The road is a gravel road, 30 ft. in width.

The timbers were obtained on the surrounding mountains at distances from 2 to 40 miles. The cast-iron piers, tie-rods and bolts were made by Masuda & Co. at Kawaguchi, and the hand-rails by Ojima & Co. at Takasaki. The bricks and cement were brought from Tokyo, while quick-lime of the best quality was cheaply obtained from a quarry in the vicinity. The advantage derived from the new railroad for the transportation of these materials was of no small value.

The building materials having arrived at the site when the river-bed became dry in October, 1886, the excavations for the abutments were commenced. The materials to be excavated for the eastern abutment consisted of strata of hard clay and sand, with vegetable earth. Thus, the material being compact, the excavation was finished with a slope of 1 in 12, and fortunately no water guttered, so that much expense was saved on this abutment. The excavation extended downwards until a bed of boulders was reached. On this bed a concrete foundation, surmounted by foundation courses of stone, was laid. The brickwork was constructed upon this foundation. The western abutment was constructed with rubble stones from the river, laid upon a foundation of piles.

The excavation for No. 1 pier was done by sinking a cylindrical crib, 6 ft. in diameter, of sheet piling 3½ in. thick, the outside of the crib being puddled with clay. Inside the crib water accumulated very rapidly, and had to be pumped out by a centrifugal pump, worked by a steam-engine and exhausting 1,800 gallons of still water per minute. At the same time gravel inside the crib was cleared out. The excavation was continued in this way to a depth of 12 ft. below the river-bed, when the accumulation of water became so rapid that there was scarcely any diminution even when the engine was working at full speed. The pressure of water and gravel on the outside of the cylindrical crib was so very great as to cause it to distort into a shape slightly elliptical, having the major axis 7 in. longer than the minor. When this occurred a layer of coarse gravel was reached, so that excavation was stopped and concrete placed for the foundation. The cast iron piers were then put in position, and filled with concrete inside and packed at the foundation with concrete between the outside and the crib. The leveling was now done, and the exact lengths of the topmost portion of the cylinders ascertained. The piers were erected by means of derricks and hemp ropes, which are the only machinery generally used by Japanese coolies. The sinking and erection of pier No. 2 were carried out in the same way as those of No. 1, excepting that puddle was not required outside the crib, the river-bed being dry in this part during winter.

While the piers were being erected, all the necessary timbers and suspension-rods were prepared, and framing of the trusses commenced, in order that all the parts of the work might progress to completion with as little delay as possible. As the formation level of the bridge is 40 ft. above ordinary water level, and the stream so rapid, being subject to violent floods in summer, a staging for the superstructure could not be easily constructed without a great expense; so that the trusses were launched into their places without any scaffolding. Of the continuous truss of two spans only one-half at first were framed, and, launched through a little less than the half-length of the framed portion, the other half was acting as the counterbalancing weight; then the remaining portion was hauled over. The launching was performed by sliding the bottom boom upon rollers by means of tall derricks and hemp ropes, so as not to touch the top of the cast iron piers while being hauled over. This was very successfully done, notwithstanding the deficiency of machinery and the fact that the work was not familiar to our workmen, so that directions had to be constantly given.

As soon as the trusses were launched over, they were set and fitted to the proper position, both in direction and level, and the superstructure was at once completed for this portion of the bridge.

While this half of the bridge was in progress, the remaining portion, consisting of a beam bridge, was being constructed, in order to push the whole work to completion with the least delay. As the river-bed at the wooden piers was dry, excavation was done with the utmost ease, except at the three piers towards the iron one, where some hand-pumps and screw-pumps were required for pumping out water. Wooden piers were here erected by means of derricks and hemp ropes, and they were braced and stiffened by crib-works filled with large stones and mortar. The beams and struts were also put in position by means of the same simple contrivance; then the planking and the hand-rails were added. Lastly, the fenders for the piers were erected in their positions. Abutments

and piers were afterwards protected by fascine-works.

The bridge was thrown open for public traffic on June 30, 1885. On the day following it was visited by a sudden flood, which rose 18 ft. above ordinary water level. This flood destroyed the fragile old bridge above the new site, but caused no damage to the new work, showing the urgent necessity for the latter.

CLASSIFICATION OF IRON AND STEEL.

THE following classification and definition of the terms "iron" and "steel" and their varieties was given by Mr. William Kent in 1883, in his expert testimony in behalf of defendant in the case of Cooper, Hewitt & Co. *vs.* Pennsylvania Steel Company, a suit brought to determine the validity of the U. S. patents of Messrs. E. & P. Martin on the open-hearth steel process. The suit referred to was decided in favor of the defendants on the technical ground that it had not been begun within the limit of time required by law, and the question of the original validity of the patents was left undecided. A few copies of the printed testimony were privately distributed, but with this exception the classification, which is here given, has never heretofore been published.

Question 36. Please give the technical meaning or definition of, and where there is any difference between the two, the commercial designation of iron; cast-iron; wrought-iron; cast steel; steel; crucible steel; Bessemer steel; open-hearth steel.

A. *Iron* is a metal which is not found chemically pure either in nature or in commerce, but is always associated with one or more metallic or non-metallic elements. The word iron when standing alone, both in commerce and in metallurgy, is used as a generic term, to designate a great variety of compounds or alloys of the element iron with other elements, but, generally speaking, it is confined to mean such compounds as are used for the purposes of construction, and does not include generally those compounds of iron with other elements which are found in a crude state in nature, and which are usually called iron ores.

The words iron ores are used to designate those compounds of iron with oxygen, of greater or less purity, (that is, associated with greater or less quantities of other elements than oxygen), which are dug out of the ground, and which constitute the original raw material from which all kinds of commercial irons and steels are derived.

Iron ores are thus always oxides of iron, but there are also other oxides of iron which are not called ores, such as iron-rust and iron-scale, both of which are formed by the oxidation of some form or other of commercial irons. Although these oxides of iron are not called ores, they may nevertheless be used like ores, as the raw materials from which commercial irons are derived by various processes; and whenever these oxides which are not called ores are used in any metallurgical process, whether as raw materials or as additions to a bath of other raw materials, they perform the same function as iron ores do.

I have stated that iron is a generic term, which is used to include a great variety of commercial products in which the metallic element, iron, is the chief component part. This includes several materials, in the name of which the word iron itself may not appear, such as steel, muck-bar, spiegeleisen, etc. Whenever, therefore, it is necessary to designate one particular variety of iron from another, some special designation other than the word iron standing by itself must be used—either iron prefixed by some adjective, as cast-iron, wrought-iron, or some other word, such as muck-bar or puddled balls or blooms.

In order to particularly define the various kinds of commercial irons which are mentioned in the question, I think it will be necessary for me to begin with a sort of classification dividing the generic term iron into its several species and varieties. Several methods of division or classification have been adopted by various technical writers. Some of these make the greater or less content of carbon the principle upon which the classification is based. Others base the subdivision upon the differences of the furnace or vessel or metallurgical process by which the finished material is obtained. Still others make a general division of the generic term iron into two classes, based upon the difference of condition in which the final product is obtained, and then subdivide these two classes into others. The latter method of classification is the one which I conceive to be the clearest, and the one which I shall now adopt.

I thus divide all the commercial products which may be included under the generic term iron into—1st, irons which are cast from a fluid mass; and, 2nd, irons which are made up from pasty masses.

Beginning with the irons which are cast from fluid masses, these may be subdivided into two classes or subdivisions: 1st, those which are malleable, that is, those which may be forged; 2d, those which are not malleable. Of the irons which are included under the second subdivision, that is, those which are cast from fluid masses and which are not malleable, I know of but one species, which is generally called *cast-iron*, but which is also called pig-iron, the word pig-iron being used chiefly to designate the shape in which this cast-iron is usually obtained. This is the commercial metal which is obtained by smelting ores in the blast-furnace. It is generally the most impure of all the commercial metals included under the generic term iron, and may contain not over 80 or 90 per cent. of pure metallic iron. It generally contains somewhere about 4 per cent. of carbon; it may contain varying proportions of silicon, of phosphorus, of sulphur, of manganese, of chromium, of titanium or other elements. Although some of these elements may be contained in only small traces, others may be in considerable quantities. Thus there have been made pig-irons containing more than 2 per cent. of phosphorus, as much as 8 per cent. of silicon, and as much as 20 per cent. of manganese. Frequently the pig-irons which contain considerable quantities of these various elements are designated by various adjectives qualifying them, such as gray pig-iron, white pig-iron, phosphoriferous pig-iron, and manganiferous pig-iron.

Passing now to the first subdivision of the irons which are cast from fluid masses, that is, those which are malleable, these may be further subdivided into two divisions or species, namely: 1st, the product which is generally known in the United States as malleable iron, also as malleable cast-iron, or as malleableized cast-iron; 2d, the various forms of cast-steel. (I must here explain that in England and sometimes in this country the words malleable iron are also used to designate another kind of a product, namely: what is ordinarily called in the United States wrought-iron.)

Tnis malleable iron, or malleable cast-iron, or mallea-

bleized cast-iron is made by removing all or a portion of the carbon from cast or pig-iron while the latter remains in a solid state. This removal is generally accomplished by heating or annealing, for a considerable period of time in a closed box, the cast-iron surrounded by some form of oxide of iron.

The second division or species of those irons which are cast from fluid masses, and which are malleable, are the cast steels of commerce. These cast-steels may generally be defined by the classification I have already given, that is, they are malleable compounds of iron which are cast from fluid masses. The one feature which distinguishes these cast steels chemically from cast-irons which are cast from fluid masses, but are not malleable, that is, which distinguishes them from pig-iron, is that they contain smaller quantities of carbon than pig-iron contains, and they also usually contain smaller quantities of those other elements than carbon, which are contained in pig-iron.

These cast steels are known by various names in commerce according to the vessel or furnace in which they are produced, such as crucible steel, Bessemer steel, and open-hearth steel. The difference between these steels does not necessarily extend further than to the furnace or vessel in which they may be produced; there is no necessary chemical or mechanical distinction between them, for cast steels may be and are produced by either one of these processes, which cannot be distinguished either chemically or mechanically from similar steels which are produced by either of the other two processes.

I will describe later in this answer the methods by which crucible, Bessemer or open-hearth steels may be produced, but will suspend this portion of my answer until after I have defined those irons which are not cast from fluid masses, but which are welded from pasty masses.

The irons which are welded from pasty masses may be subdivided into two classes: 1st, wrought or welded irons; 2d, wrought or welded steels. The wrought-irons may again be subdivided into different varieties of wrought-iron according to the furnace in which, or the process by which, they may be obtained. I subdivide them into two classes: 1st, those obtained by direct processes from iron ore or from iron scale; 2d, those which are obtained by indirect processes or by the refining of pig-iron. The wrought-irons obtained by the indirect and by the direct processes are not distinguishable from each other by mechanical or chemical means, but are only distinguished as regards the processes by which they may be obtained. The general method of obtaining wrought-irons by direct process is the reduction of the ore to the metallic state by carbon or carbonic-oxide gas, and heating the reduced ore to the welding-point and welding together the mass into the finished product. This product, before any subsequent operations are performed upon it, is generally known as a wrought-iron bloom. There are many different methods of conducting this process, such as the Catalan process, the Siemens direct process, Chenot process, etc., which I need not further refer to, as their general method as well as their product is the same.

If in this direct process there is an excess of fuel used and a temperature higher than the welding temperature, in addition to the reduction of the iron of the ore to the metallic stage: another feature or metallurgic process may be accomplished, namely, the absorption by the metallic iron of other substances in greater or less quantity, as carbon, silicon, etc. If the absorption of such substances, especially the carbon, is to such a degree that the finished product is much harder than wrought-iron, but still retains the pasty condition during the whole time it is in the furnace, the resulting product may then be known as steel, or wrought or welded steel, instead of wrought-iron.

If the absorption of carbon, due to the high temperature and the excess of carbon present, is so great that the metal becomes liquid in the furnace and is cast from this fluid mass, the resulting product would then be known either as cast or pig-iron, or as cast-steel, according to the greater or less percentage of carbon it contained.

The direct process, therefore, of producing at one operation from the ore, wrought-iron, wrought-steel, cast-steel, or pig-iron, may be the same kind of a process, differing only in the greater or less absorption of carbon during the operation. If the absorption is the least possible, the product is wrought-iron; if it is a little greater, but the product still retains the pasty condition while in the furnace, the product is wrought-steel; if the absorption is still greater, so that the metal becomes fluid at the last stage of the process, the product is cast-steel or pig-iron, according to the amount of carbon contained in the finished product.

Wrought-iron may also be produced, as I have stated, by an indirect process, that is, from cast or pig-iron, by the removal therefrom of the carbon and other elements to a greater or less extent. This removal of the carbon, or what is called refining, may be carried on in different kinds of furnaces, such as the Lancashire hearth and the puddling-furnace.

I have stated in a previous portion of this answer that malleable or malleableized cast-iron is cast or pig-iron which has had the carbon taken out of it by heating or annealing in closed boxes in presence of oxide of iron. The oxygen in the oxide of iron in this case is the agent of refining, that is, of the removal of carbon. In all refining operations for the removal of carbon from pig-iron, or from steel, or from any form of iron whatever, the agent of refining is oxygen. The oxygen unites with the carbon and forms carbonic-oxide gas, which escapes.

This oxygen may be derived from oxides of iron, such as iron ore, iron scale or iron rust, from the atmosphere, from carbonic-acid gas, or from oxides of other metals than iron. In whatever form the oxygen is applied, whether to iron in the solid state, as in the making of malleablized cast-iron, or in any of the various operations of iron or steel manufacture in which carbon is removed from the metal, the operation is the same, namely, the formation of carbonic-oxide gas by the union of carbon and oxygen.

In the puddling process, which is the process most generally used for the production of wrought-iron from pig-iron, the carbon is burnt out of the pig-iron by oxygen, which is derived both from the excess of atmospheric air or of carbonic acid gas in the flame which traverses the surface of the metal, and from the ore and scale by which the bed of the furnace may be lined, or which may be added to the bath during the operation. In the refining process, which is used sometimes as a preliminary stage to the puddling process known as the "refinery" or the "run out" process, part of the carbon and the silicon is burned out by the oxygen of atmospheric air, which is projected downward into the bath of metal.

I have now defined the wrought irons which are welded up from pasty masses, and which may be produced

in two ways: 1st, direct from the ore by one form or other of "direct process;" 2d, indirectly from pig-iron by some form or other of refinery process.

I have also shown that a wrought-steel may be formed by the carbonization of the metal in the direct process. A wrought-steel may also be formed in the indirect or refinery process, puddling or other, by arresting the decarbonization before the carbon is burned out to the degree that it is in producing wrought-iron; or, in the same process, by decarbonizing to the fullest extent, and then recarbonizing by an addition of some form of iron or steel which contains more carbon than wrought-iron. There is still a third method of producing wrought-steel known as the cementation process, which consists in taking wrought-iron, whether produced by the direct or indirect process, by adding carbon to such wrought-iron while it remains in the solid state; this is the inverse of the process of making malleableized cast iron. It is generally performed by surrounding bars of wrought-iron by charcoal in a closed box or furnace and heating them together for a considerable period of time. If such heating is continued long enough the amount of absorption of carbon may be as much as 4 per cent., in which case the resulting product will have lost one of the distinguishing features of ordinary steel, namely, malleability, and becomes similar in its content of carbon, as well as its non-malleability, to cast or pig-iron. Steel made by cementation process is generally called blister or shear steel. Puddled steel is the product of the puddling-furnace when the puddling process is arrested before the decarbonization is completed, as for wrought-iron, or when it is so completed and the subsequent addition of a recarbonizer is made, the product in both cases being withdrawn from the puddling-furnace while in a pasty condition.

I now come to define and distinguish the cast-steels which I have already referred to, namely, crucible, Bessemer and open-hearth steels.

The finished products known by these names do not differ in quality, but only in the process by which they are obtained. The characteristics which they all hold are that they are malleable, are cast from fluid masses, and contain a smaller amount of impurities than cast or pig-iron. By impurities I mean carbon, silicon and other elements. They always do contain, however, a certain amount of these impurities, and they generally, though not necessarily, contain a larger amount of carbon than is found in wrought-iron.

In addition to the names crucible, open-hearth and Bessemer, by which these steels are designated they also have other names given to them to designate their quality as soft and hard steel, high and low carbon steels, or steels of various percentages of carbon.

The percentage of carbon in steel determines its hardness, and chiefly the purpose for which it may be used.

It is evident that as these steels contain always less carbon and other elements than are found in pig or cast-iron, and generally more carbon than is found in wrought-iron, they may be made either by refining or decarbonizing pig or other highly carbonized irons, or by adding carbon to the purer wrought irons, or by mixing and melting together irons containing respectively higher and lower percentages of carbon; or they may be made directly from the ore by deoxidizing such ore—that is, reducing it to the metallic state—and adding the requisite quantity of carbon, either from the fuel or from some carbonaceous substance added for the purpose, or from the addition of pig or other highly carbonized iron, or by any combination of any two or more of these methods of decarbonizing, deoxidizing, carbonizing or recarbonizing. In other words, beginning with pig or other iron containing a high percentage of carbon, and iron which may contain no carbon at all, and steel which contains more or less carbon, a cast steel containing any required percentage of carbon may be made by addition and subtraction, or mixing or diluting or combining in any form whatever two or more of these materials; or it may be made by beginning with pig or other highly carbonized iron, and burning out the carbon by oxygen derived from any source whatever, even by pure oxygen gas, as is mentioned in one of the patents of Messrs. Martin; but such cast-steel, however made, is cast from a fluid mass, and is not welded up from a pasty mass at the end of the operation.

Crucible steel is distinguished from Bessemer and open-hearth steel by its being made in a crucible or small pot, which is generally provided with a lid; a mixture of steel-making materials is made and placed in this crucible, and the whole is thoroughly melted, and poured into an ingot-mould. The mixture may be of various kinds and of various proportions. In this mixture may be used iron ore, pig-iron of various kinds, wrought-iron, steel of various kinds, and in general any of the products which are included under the generic term of iron, as well as other substances, such as charcoal, various carbonaceous matters, metallic manganese, or alloys of the same with one or more metals, and a vast variety of other substances. The operation of making crucible steel may be a refining process, in so far as pig-iron may be used as the principal raw material, which is decarbonized by the oxygen of the ore or other oxides placed in the crucible. It may be a reaction or mixing process, in so far as a mixture may be made of iron highly carbonized, and of one which contains little or no carbon. It may be a reduction and a carbonizing process, in so far as iron ore may be used as the principal material, which is deoxidized and carbonized by carbon or carbonaceous substances of which the crucible may be composed, or which may be added in the crucible. It may be a decarbonizing in combination with a recarbonizing process, as in the case in which pig or other highly carbonized iron is the principal component of the mixture which is decarbonized by the other components, such as oxides of iron or of manganese, wrought-iron, etc., and recarbonized by a subsequent addition of a recarbonizer before pouring. The crucible process is thus susceptible of a great variety of modifications.

The Bessemer process for the manufacture of steel has for its chief feature the refining or decarbonization of pig-iron in the vessel known as the Bessemer converter by the oxygen of atmospheric air, which is generally introduced at the bottom, or below the surface of the bath of melted cast-iron, but which may be introduced downwards, from the surface. The carbon is burned out of the pig-iron either to the degree required to form steel, and then the metallic bath is poured into ingots, or the carbon may be entirely burned out, and the bath recarbonized to the required degree by an addition of a quantity of cast-iron. The Bessemer process is thus chiefly a refining process. It may be the combination of a refining process and a recarbonizing process, but it may also be a refining process in combination with a mixing, dilution or reaction pro-

cess, in so far as there may be, and, in fact, there usually is added to the bath of cast-iron a quantity of steel scrap. As I have already stated, in all processes in which refining is a feature the agent of refining is oxygen. The refining agent in the Bessemer operation is the oxygen of the atmospheric air.

The peculiarity of the open-hearth process which distinguishes it from the Bessemer and the crucible process is that the operation is carried on upon the bed of a reverberatory furnace, and the bath of metal is exposed to the action of the flame which traverses its surface, although this surface may be protected more or less by a layer of slag; as in the crucible process, so in the open-hearth, a great variety of mixtures may be made. The process may be either refining of pig-iron by oxygen derived from various sources; it may be a dilution of the carbon of the pig-iron by additions of wrought-iron or of steel. It may be a reduction and a carbonizing process, in which iron ore is the principal raw material, which is deoxidized by the addition of carbonaceous substances. It may be a carbonizing process, in which wrought-iron or low carbon steel is the principal component of the mixture—the carbonizing being effected by carbonaceous substances or by highly carbonized irons. Or it may be either one of these processes or a combination of two or more of them in combination with a process of recarbonization by the addition of a recarbonizer such as I have already mentioned in the crucible and Bessemer processes.

The mixture or bath of the open-hearth furnace may be formed in a variety of ways: an initial bath may be made of pig-iron, to which may be added successively and in small pieces the various additions for the purpose of diluting; or the additions may be made to the pig-iron all at one time, either before or after the latter is melted; or the initial bath may be of wrought-iron, or of steel, to which pig-iron or other substances may be afterwards added. Generally speaking, the open-hearth process is susceptible of a greater variety than either the crucible or the Bessemer process, inasmuch as all the possible mixtures of both the Bessemer and the crucible process may be used; they may be added to the bath either separately and in small pieces or all at one time, and either cold, or heated or melted. While the refining of the crucible process is generally accomplished by oxygen derived only from oxides of iron or other metals, and the refining in the Bessemer process by oxygen derived from atmospheric air alone, possibly supplemented by oxygen derived from steam introduced with the air, the refining in the open-hearth process is accomplished by oxygen derived both from the oxides of iron or other metals which are in the original mixture or which may be added to the bath, and from the excess of oxygen in the slag which lies upon the surface of the bath, as well as from the excess of atmospheric air or of carbonic-acid gas in the flame which traverses the bath.

The open-hearth process also gives greater facility for testing the quality of metal in the bath, both because the furnace is of a more convenient shape, and because the operation may be delayed for any length of time by the workmen in order to take out and test samples. The number of possible modifications of the open-hearth process is so great that they cannot all be specified; but I may briefly say that the open-hearth process includes every possible method of producing upon the bed of a reverberatory furnace a metallic bath, whose constitution is that desired in the finished product, namely, cast steel, and casting the same from the fluid state into ingots or other masses; and open-hearth steel includes all varieties of steel which are cast from a fluid mass contained upon the open-hearth of a reverberatory furnace, whatever may have been the method used to produce such fluid mass.

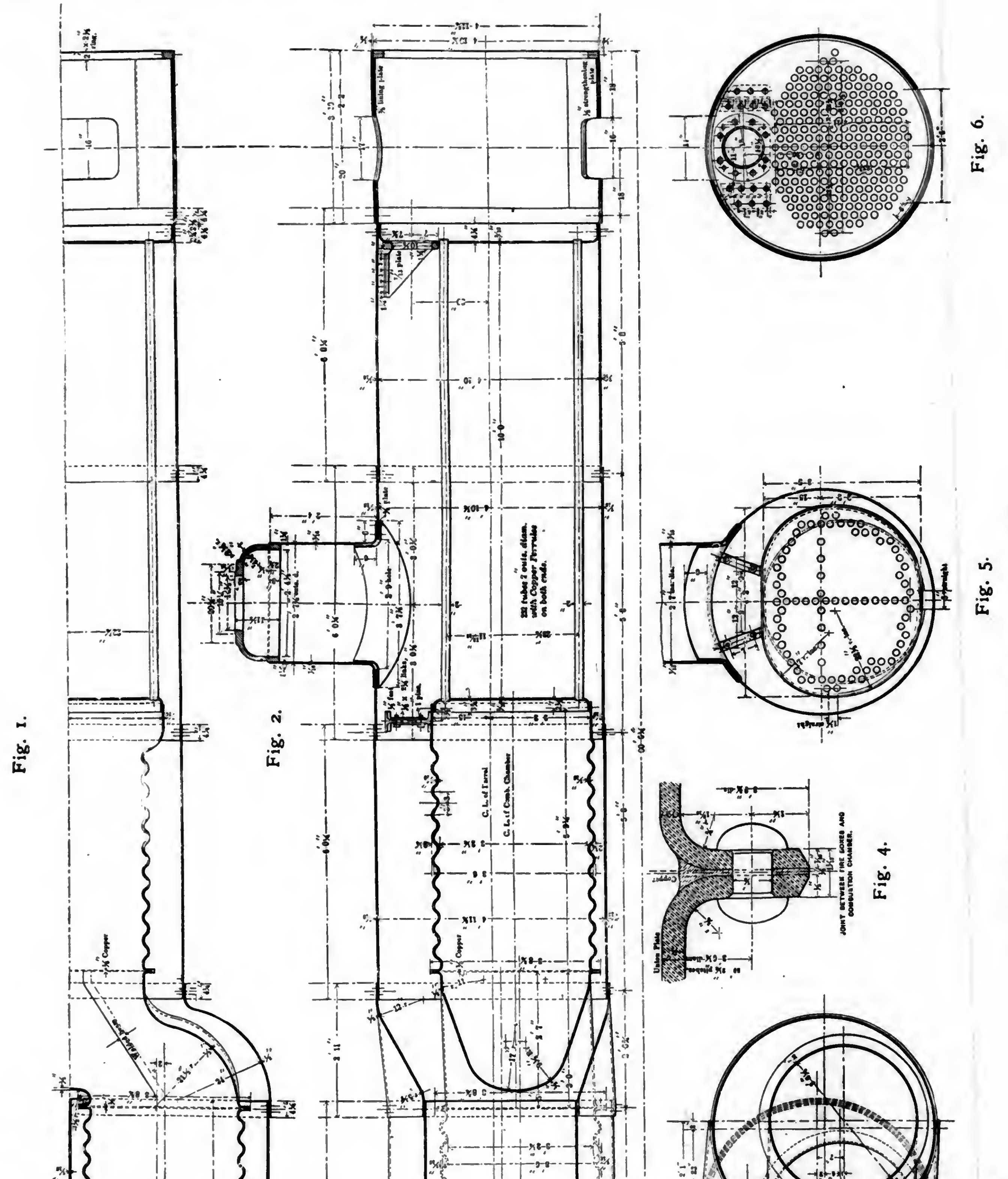
Mr. Kent has furnished us the following diagram of the classification which he adopted in his testimony, adding to it the term *mitis*, which was not known in 1883.

CLASSIFICATION OF IRON AND STEEL.—KENT

Generic term	IRON.							
How Obtained	CAST, or obtained from a fluid mass.						WROUGHT, or welded from a pasty mass.	
Distinguishing quality	Non-malleable		Malleable				Will harden	Will not harden
Species	CAST IRON		CAST STEEL				WROUGHT IRON	WROUGHT STEEL †
Varieties	Ordinary Castings	Malleable Cast iron (Made from No. 1. by annealing in oxides.)	Crucible Steel	Bessemer Steel	Open-Hearth Steel	*Mit*	Obtained by direct Process from ores. Catalan Siemens Chenot and other process irons / Obtained by indirect Process from Cast Iron Finery Lancashire and puddled irons — Common wrought iron.	Obtained by direct or indirect process. German Shear Blister and Puddled Steels. †
No.	1	2	3	4	5	6*	7	8†

* No. 6., *Mitis* is the name given to a new product (having the same general qualities and produced by the same processes as soft cast steels, and therefore classified with them), distinguished by great fluidity in pouring and casting, which is secured by adding an alloy of aluminum to the metal before pouring.

† No. 8., Wrought Steel including German, puddled, blister and shear steel is nearly an obsolete product, having been replaced in commerce by those qualities of cast steel which will harden and temper.



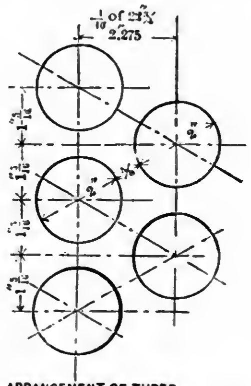
BOILER OF STRONG'S LOCOMOTIVE "DUPLEX."

STRONG'S LOCOMOTIVE "DUPLEX."

A DOUBLE-page engraving, from a photograph of this remarkable locomotive, was published in the last number of the JOURNAL.

This locomotive is, in many respects, a new departure from ordinary locomotive practice. It was built for heavy mountain passenger service on the Lehigh Valley Railroad, at the Wilkesbarre shops of that company, under the supervision of Mr. Alexander Mitchell, Division Superintendent of that line, from the design of Mr. George S. Strong. The engine, as will be seen from the engraving published last month, has six coupled driving-wheels, 62 in. diameter, a four-wheel leading truck and a single-axle or "pony" trailing truck under the fire-boxes. The cylinders are 20 × 24 in. The total weight of the locomotive is 137,000 lbs., of which 27,000 lbs. is on the leading truck, 90,000 lbs. on the driving-wheels and 20,000 lbs. on the trailing truck. This makes it probably the most powerful passenger engine ever built.

The most striking and most novel features of the engine



ARRANGEMENT OF TUBES

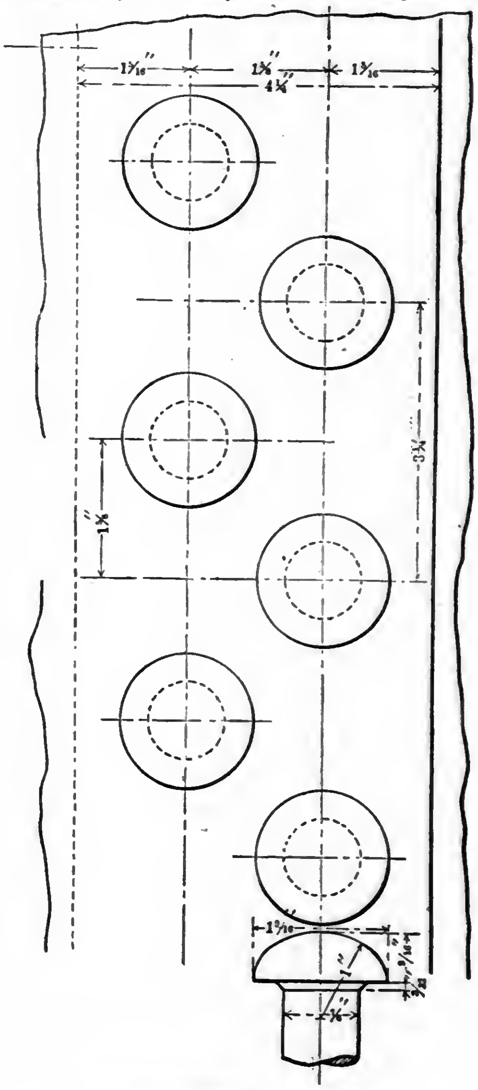
are the boiler and the valve-gear. Mr. Strong has assumed that for heavy and fast passenger service two things are required, first, a boiler that will supply an abundance of steam, and second, a valve-gear that will admit and exhaust the steam to and from the cylinders promptly. With a view to securing abundant steam-generating capacity he has designed the boiler represented by figs. 1 to 6. Fig. 2 shows a sectional view, on a vertical plane through the center of the boiler. Fig. 1 shows a half section on a horizontal plane through the center line. Figs. 3, 5, and 6 are transverse sections through the fire-boxes, combustion chamber and barrel of boiler, respectively. The engravings are from a standard four-coupled express-engine, similar to the *Duplex* in every respect except size.

As will be seen from the engravings, the boiler has a double fire-box, the fire-box casing being bifurcated, resembling somewhat the legs of a pair of trousers. Each ot the separate fire-boxes consists of a steel cylinder which is corrugated circumferentially. The cylinders are united at their front ends to a single combustion chamber, also composed of a corrugated steel cylinder. The gases generated in the fire-boxes are discharged over a hollow bridge where they receive a supply of heated air to produce perfect combustion, and, by alternate firing, an incandescent fire, it is claimed, can always be maintained in one side to burn the gas produced in the opposite fire-chamber, which has been charged with coal last.

The steel junction piece, by which the fire-boxes are united to the combustion chamber, is made originally of three plates formed on dies in a hydraulic press and then welded up and flanged out to join the ends of the fire and combustion chambers, so as not to expose a single rivet to the direct action of the fire.

The combustion chamber is also a welded and corrugated steel cylinder, flanged out to receive a full-sized tube-sheet. These internal parts are capable of standing 1,100 pounds per square inch, external pressure. The longitudinal seams on the outer part of the boiler are all welded, and the circular seams, the only ones riveted, are united by a double row of rivets, placed as shown.

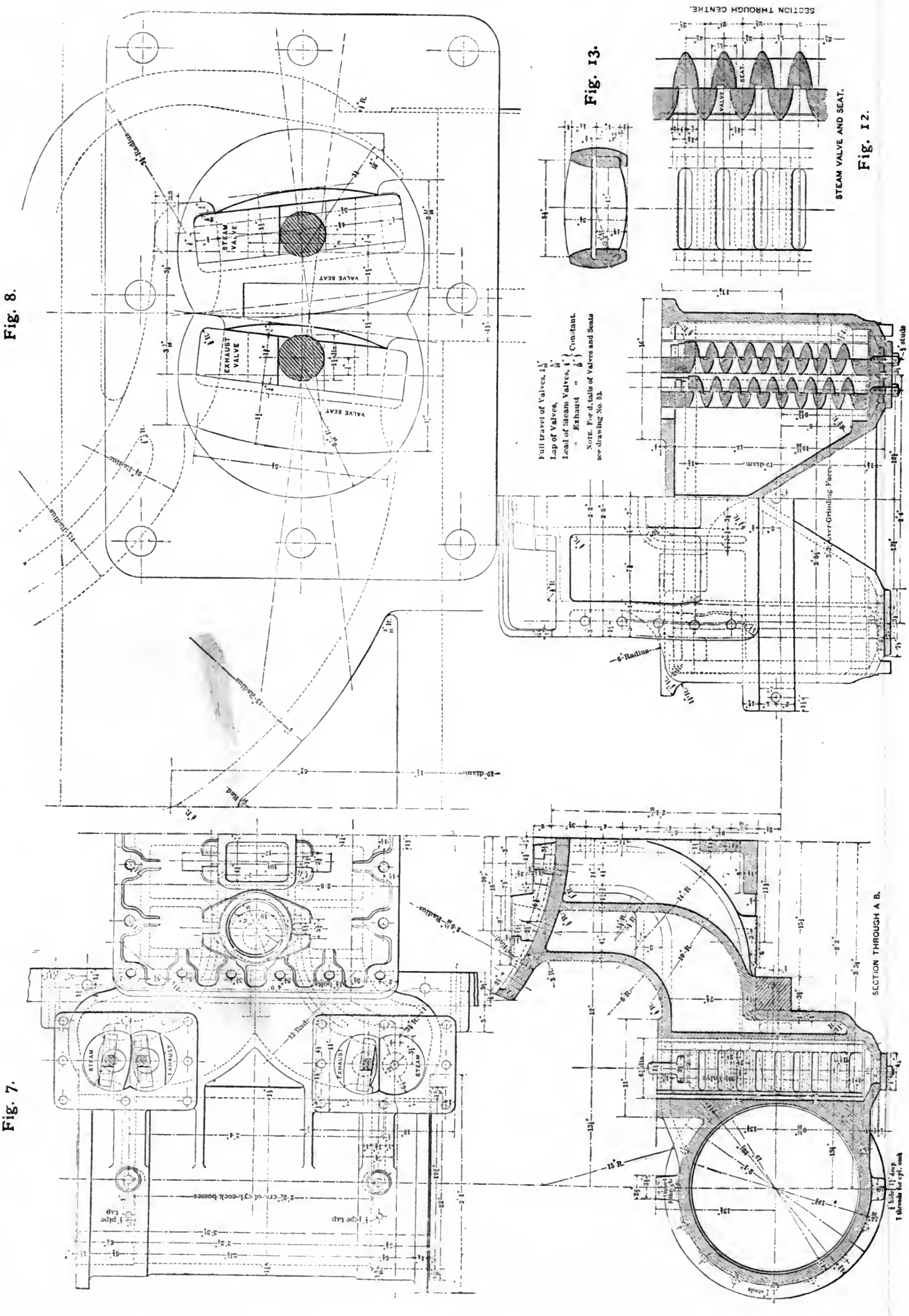
As the corrugated fire-boxes are capable of resisting a very great external pressure, and the outside casing a pressure internally, no stay-bolts are required, and we



ARRANGEMENT OF RIVETS.

thus have the novelty of a locomotive boiler entirely without stay-bolts. The grate area is 62 square feet, and the total heating surface is 1,848 square feet. Figs. 7 to 12 represent the cylinders and valves of this engine, and figs. 14 to 16 the valve-gear, which is described as follows by the inventor:

"It is a well-recognized fact in steam engineering that the best engine is the one that gives the highest initial and lowest terminal pressures, provided it is tight and is working up to its full capacity (*i. e.*, has a full load). To do this there must be a good admission, an early cut-off, a late release, a free exhaust and a late closure of exhaust, with enough compression to bring the pressure of the confined steam up to that of the boiler at end of stroke.



CYLINDERS OF STRONG'S LOCOMOTIVE, "DUPLEX."

"Much has been written on this question of compression, and some have asserted that it was impossible to run a locomotive at a high speed with any less compression than that given by the link motion, but they have not taken into account the question of clearances. We have found that when clearances are reduced compression must be reduced, and that with an engine having small clearances a very small amount of compression answers every purpose, and that more will deaden the engine.

"Here was a great problem to solve, and one that has taken years of careful experiment and investigation. We are required to produce an engine with independent steam and exhaust valves, which is at the same time simple, durable and practical.

"Many attempts have been made before, and many failures recorded. Careful investigation soon satisfied the writer that the flat slide or gridiron valve was the only one that would answer the purpose. Valves of this kind have stood the test for years with high pressure steam in both stationary and marine practice, but to be a success these valves must be allowed to come almost to rest while the load is upon them; wherever previously used some form of cam or tappet motion had been employed to actuate them. In our first experiment we tried a device of this kind, but soon found that with the rapid motion of a locomotive it would not do at all. We then devised the very simple arrangement of rocker shown, which is so adjusted that after a valve has traveled its lap it comes to nearly a full stop, while the corresponding valve at the other end of the cylinder is doing its work, and as the load comes upon the valve during this period of rest there is very little wear. As the steam of compression comes up under the valve at its period of opening there is a still further relief, while the exhaust valve does not move until it is relieved by expansion.

"The method of introducing the valves and seats is clearly shown by the drawings. The valve-seats are plugs, fitting in holes bored in the passages from the saddle to the cylinder, the ordinary steam-chest being dispensed with. The valves are let into grooves milled or planed in the seats, so arranged that the valves are free to move up and down in the seats.

"There are ten ports in each seat on a 19 × 24 in., or a 20 × 24 in. cylinder, each port being $4\frac{5}{8}$ in. long and $\frac{3}{4}$ in. wide, giving a total port length of $46\frac{1}{4}$ in., in each valve. This length is also, of course, that of the lead line, as against the 16 in. of an ordinary locomotive. This arrangement, even when the engine is making 250 revolutions per minute, gives an initial pressure within 2 pounds of boiler pressure, and does not allow more than 5 pounds drop to the point of cut-off; while the ordinary form of valve will entail a loss of 15 pounds between boiler and initial pressures, and another 15 during the period of admission, making a loss of 30 pounds between boiler pressure and that at the point of cut-off; while under similar circumstances we do not by any chance lose 10 pounds. We cut off at 4 in., and hold on to the steam until the last inch of piston travel, thus getting 6 expansions. The exhaust does not close until $3\frac{1}{2}$ in. from the end of the return-stroke, avoiding excessive compression. An ordinary locomotive loses 33 per cent. of the mean effective pressure from compression, which necessitates a late cut-off and not more than 3 expansions, in order to maintain the same mean effective pressure that we get with 6 expansions. Now, it will be readily seen why the link-motion is not good for very fast and heavy work. It can neither get the steam in nor out properly. In losing at both ends, it exhausts at too high a pressure and does not allow an initial pressure at all near that of the boiler. All these objections are entirely overcome by the valve-gear shown, which is of the radial type.

"The motion for all the valves on one side of the engine is obtained from a single eccentric, one motion of the lever attached to the eccentric moving the valves the amount of their lap and lead, and another motion produces the opening in addition to the lead. There are two levers worked from the same eccentric strap; one being bolted rigidly to it, while the other has a pin forged on the end of it. This pin has a bearing in a bushed hole in the strap itself. Both these levers have a fulcrum pin, at a certain distance from their ends, connected with one end of a link whose other end is hung by means of a pin from a block, capable of being moved along a sector or arc. The path of the pin, when moved along this arc, is radial to the fulcrum pin already mentioned. Thus the position of this block on its sector, which is regulated through the medium of a reach rod by the lever in the cab, determines the inclination of the travel of the fulcrum pin. When the block stands in the center of the sector, as shown on the drawing, there is no inclination to the travel of the pin, and the valve is moved only the amount of lap and lead. If, however, the block is moved forward on the sector, the fulcrum pin travels over an inclined path, which incline represents the opening of the valve in addition to the lead, and the engine moves forward; and if the block is moved forward to the end of the sector, the full travel of the valve is given, and steam follows the piston 20 in. of its 24-in. stroke; if, on the other hand, the block is moved back past the center, the path of the fulcrum pin is reversed, and the engine will run backwards. Thus it will be clearly seen that, by varying the position of the block on the sector, the travel of the valve is varied as well as the point of cut-off, which latter may be anywhere between 4 in. and 20 in. In all cases the exhaust valve is allowed to travel its full stroke, and as it is worked by the lever having the pin forged on its end, and from a separate fulcrum pin, with an independent link, block and sector, its travel may be varied at will, and so, of course, may the steam valve. In ordinary working, however, the exhaust block is never moved on its sector, except for reversing, when both steam and exhaust blocks are moved at the same time; after the engine is started the steam valves are hooked up, but the exhaust is not disturbed. The steam valves are given $\frac{1}{8}$-in. lead and the exhaust $\frac{5}{16}$ in."

The performance of this engine will be watched with a great deal of interest. It is now in service on the Lehigh Valley Railroad, and it is reported that it makes an abundance of steam with the fastest and heaviest trains up the mountain grades of 96 ft. per mile, doing the work of two ordinary locomotives with the finest buckwheat or pea coal (anthracite), or with screenings with all the culm in it.

This locomotive is controlled by the Strong Locomotive Company, of 239 Broadway, New York, of which company Mr. A. G. Darwin is President; George S. Strong, Chief Engineer. The directors of the company are: A. G. Darwin, C. C. Worthington, Thomas F. Rowland, H. G. Morris, Geo. D. McCreery, Geo. H. Meyers, and Geo. S.

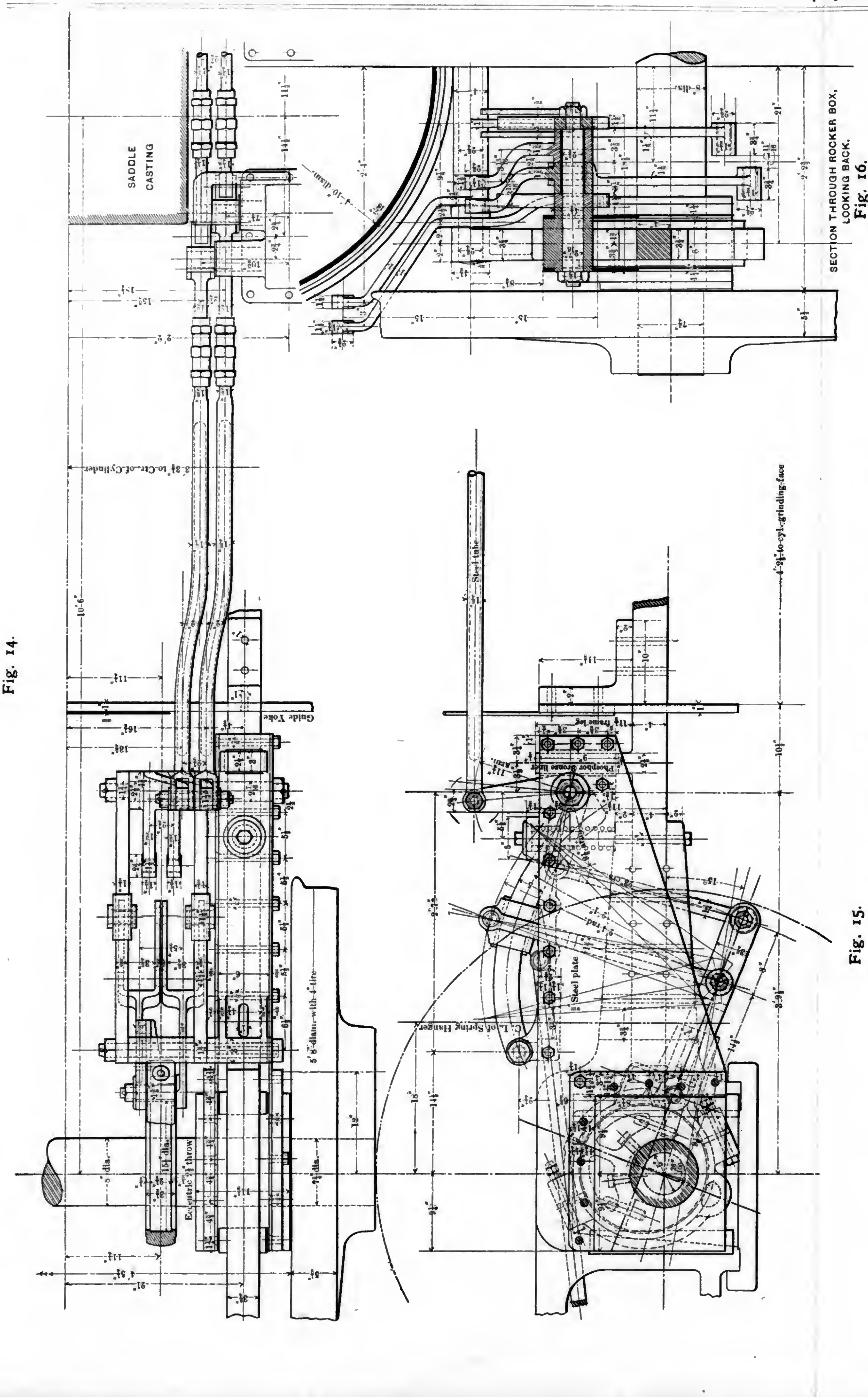


Fig. 14.

Fig. 15.

Fig. 16.

VALVE-GEAR OF STRONG'S LOCOMOTIVE, "DUPLEX."

Strong. It is the intention of this company to have the locomotives built by regular builders except the boiler, which requires special machinery for welding, flanging and corrugating. This machinery the Continental Iron Works, of Greenpoint, Brooklyn, have constructed and have in operation, and they will make the boilers, or supply the welded, flanged and corrugated parts for their construction elsewhere. The other parts of the locomotive do not, of course, require any special plant or other tools than those found in any shop well equipped for locomotive building.

Latowski's Bell-Ringer.

The accompanying engraving represents a bell-ringer invented and patented by Mr. Robert Latowski, of Munich, Germany, which has already come into extensive use (over 1,500 having been made) on German railroads, and also for steamboats, factories, etc.

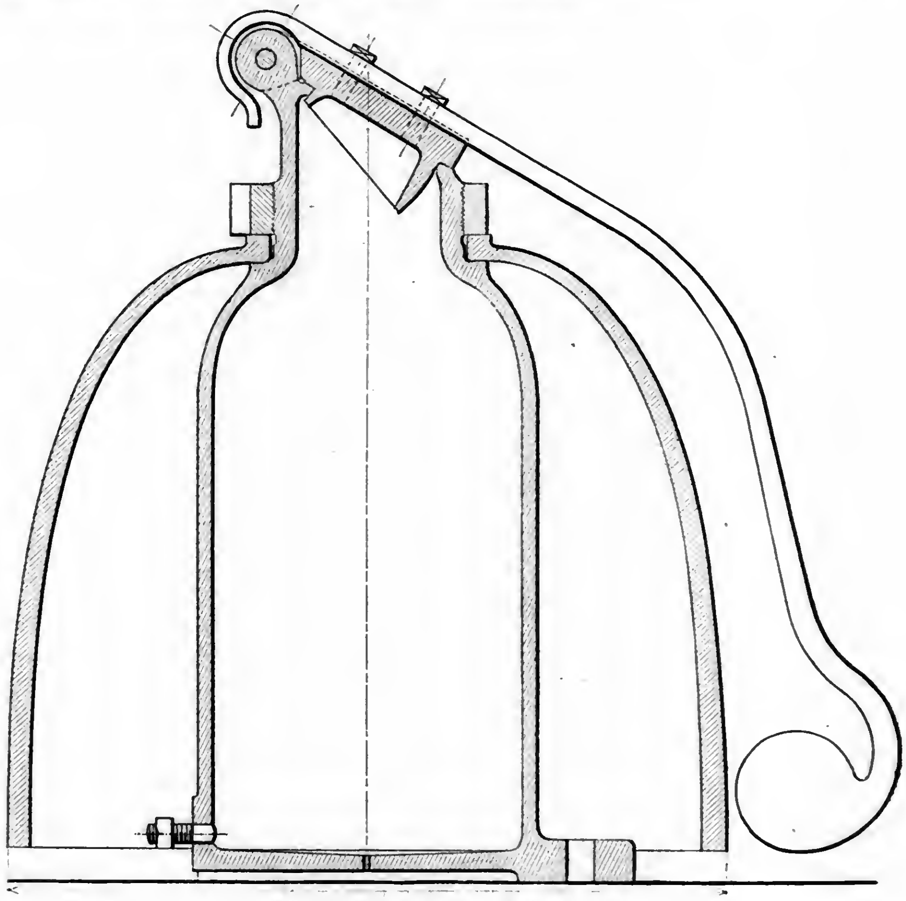
As will be seen from the engraving—a cross-section through the center—the bell-ringer is a box or chamber, to which the bell is secured at the top by a nut or collar.

Steam is admitted into the chamber by a small opening at the bottom. At the top is a much larger opening, which is closed by a safety-valve; to this safety-valve is attached the hammer, which strikes on the outside of the bell. Owing to the size of the safety-valve opening, a larger amount of steam will escape than that entering the chamber in a given time, and the sudden decrease of pressure thus produced will cause the valve to shut quickly. The admission of steam being continuous, the opening and closing of the safety-valve will produce a continuous oscillation of the hammer attached to it, and a consequent ringing of the bell.

For the purpose of increasing the lift or stroke of the valve and hammer, the valve is provided with an interior ring or boss, which, acting as a loose piston, does not close the opening tightly, but requires a certain lift to give free egress to the steam.

When at rest (as shown in the cut) the hammer does not touch the bell, but when the valve closes the weight of the hammer and the spring of the handle cause it to strike; the rebound from the bell also assists in the opening of the valve. The spring or handle carrying the hammer is prolonged over the hinge of the valve, serving both as a check to prevent it from opening too widely and as a spring to assist its rapid closing.

A small hole is bored at the bottom of the chamber to discharge any water which may form inside it by condensation.



LATOWSKI'S BELL-RINGER.

In practice it is found that a steam pressure of about two atmospheres is quite sufficient for the working of this apparatus, and that the bell will be struck at regular intervals, while the operator or engineer will readily learn to give such signals as may be desired.

The size which the makers recommend as suited to large locomotives has a bell (of cast steel) about 19¾ in. diameter, the weight being about 170 lbs. The apparatus can, of course, be made of any size required.

Enterprising Journalism.

The following correspondence has been made public;

"*Judge Thomas Russell, Chairman Massachusetts Board of Railroad Commissioners, Boston, Mass.—Dear Sir:* We beg to inform you that we now have in our possession, subject to your order for production at the investigation of the late disaster, the two broken hangers which, in our judgment, were undoubtedly the immediate cause of

the disaster, since nothing worse can have existed in a bridge which stood up 11 years, and they came from just the point where the facts seem to require the break to have been—at the first panel of the north truss from the farther abutment.

"They are the two floor-beam hangers. One of them was cut completely off at two points by old and deeply rusted breaks, leaving about one-twentieth inch effective section. It would not hold up 100 pounds safely. The other is cut, likewise, by two old rusted cracks at two different points, for about one-fourth its periphery and one-eighth its section. It would safely carry about a ton, perhaps.

"We sent Mr. Henry S. Pritchard, civil engineer, a practical bridge man, to get the bottom facts for us, if he could, and he did so. He arrived on the ground 27 hours after the accident, spotted the probable cause of the difficulty, noted that the broken parts were being hauled off, to be scraped, apparently; asked one of the laborers employed in the work to knock out the pin for him, and set these broken parts free, which he did at once, and brought them on to us in accordance with his general instructions to pick up any specimens of technical interest he could get. We had no idea nor expectation of being able to pick the key to the whole mystery out of the scrap heap, but, having done so, propose to see that proper use is made of it, by delivering the specimens only to the proper party, and we hope only for investigation purposes, We shall exhibit the specimens at the meeting of the American Society of Civil Engineers to-night, and I would like that they should remain the property of the society,

"I should add that, beside the cracks, the workmanship and material of the two specimens are both execrable. Taking into account, likewise, the nondescript character of the bridge 'design' as a whole, the Ashtabula Bridge was a triumph of engineering compared with it.

"We have received to-day the subjoined dispatch (or Mr. Pritchard did) from an engineer in Boston who has likewise acted for us in this matter.

"'Henry S. Pritchard, care Wellington, *Engineering News*, Tribune Building, N. Y.: Prof. Vose, *having authority* (all italics ours) says that if broken pieces are sent at once to the Superintendent of the Boston & Providence Railroad, *no remarks will be made*. You need not come now. Probably you won't have to come at all.'

"We don't know what remarks it was supposed would be made, but as we came in possession of the specimens in a perfectly proper way and in the public interest, as did also Mr. Pritchard, anyone is at liberty to make any remarks they please, so far as we are concerned, and we shall exercise the same privilege in the *Engineering News*. As an engineer and Massachusetts man I blush that such things are possible in the State, and I hope our spade will be called a spade in the findings of the commission. Respectfully,

"A. M. WELLINGTON,
"Editor *Engineering News*.

"March 15, 1887."

"*A. M. Wellington, Esq., Editor Engineering News.—DearSir:* In your favor of 15th inst. you notify us that you have portions of two broken floor-beam hangers taken from the wreck at the South Street crossing on the Boston & Providence Railroad, and that they exhibit old and deeply rusted breaks, which, in your judgment, were the immediate cause of the disaster.

"The other portions of these same two hangers, showing the other sides of the breaks, are now in the office of the Commissioners, having been preserved by the company and sent to us, in accordance with an agreement entered into the day before your reporter made his discovery. Both portions of the two broken hangers were examined by several experts and by myself three or four hours after the accident, and it was at that time that the company, in accordance with my request, agreed to preserve them. Furthermore, an expert was employed by the Commissioners, and another by the railroad company, to make a critical examination of the whole wreck, and to see that any other important portions were also preserved. The portions of the hangers in your possession belong to the railroad company and not to us, and we have no doubt that the company, as soon as they are restored to it, will at once, in accordance with its agreement, place them before us for further examination. Upon this point you need have no anxiety.

"It is not for us to characterize the action of a reporter who, taking advantage of the privileges accorded him, carries off important portions of a wreck without the consent of the owner, but you can readily see that it would be necessary to exclude all reporters from access to wrecks if the course adopted by Mr. Pritchard, in accordance with your instructions, was considered justifiable and should be adopted by other journalists.

"We appreciate the evident desire to be helpful which prompted your action, and thank you for the expert opinion contained in your letter.

"Hon. Thomas Russell, the late Chairman of the Board, to whom your letter was addressed, died about a month ago.

Yours,
"GEORGE G. CROCKER, Chairman.
"For the Board of Railroad Commissioners."

Steel: Its Properties; Its Use in Structures and in Heavy Guns.

[Abstract of paper read before the American Society of Civil Engineers, at the meeting of March 2, by Mr. William Metcalf.]

MR. METCALF begins his paper by a few definitions, made necessary by some apparent confusion in recent writings.

The word temper has two distinct meanings among steel-makers. Applied to steel not hardened, the temper is said to be mild, medium or high, according to the amount of carbon the steel contains; thus we recognize and use daily in the crucible-steel business tempers, each so distinct from the other in the fractured ingots, that there is no uncertainty in their selection and separation.

The mean difference in carbon between any two adjacent tempers is .07 per cent. When speaking of the temper of a piece of tempered steel, the final condition of the steel is referred to, that is to say, it is straw-color, orange, light brown, brown, pigeon-wing or blue, as the case may be. If the piece has not had the temper drawn, it is said to be hardened and not tempered.

To temper a piece of steel is to heat it, harden it by quenching, and to draw the temper to the color or degree of softness required.

The recent United States Navy specifications would read better if they said to be annealed, hardened in oil, and to have the temper all drawn out.

Steel-makers call the last operation drawing black.

Annealing steel is the operation of heating it slowly and uniformly to the necessary degree to soften it, or to relieve internal strains, or to secure uniformity of texture.

The question of what is steel was left in a mixed state by recent discussions. The law says that "steel is iron which has been produced by fusion by any process, and is malleable."

Mr. Metcalf offers a new definition: "Iron is a liquid." This was suggested independently by two persons, U. S. Senator John T. Morgan and Prof. John W. Langley, of the University of Michigan. Professor Langley was the first to observe the varying rate of expansion due to increase of temperature between high steel and low steel. He was also the first to note the presence of free oxygen dissolved in iron, a discovery confirmed by late researches of European chemists.

This liquid, which we will consider now in the form known as steel, congeals at a high temperature; as it congeals it crystallizes in as many forms almost as are to be found in snow-flakes. The sizes and forms of the crystals are affected, *first*, largely by the rate of cooling; slow cooling favors the formation of large crystals and quick cooling produces small crystals. Chernoff observed farther that agitation produced fine crystals, and gave this as the reason why a heavy hammer, thoroughly and quickly applied at the right time, produced fine grain, increased density and greater strength.

Second.—The size and form of the crystals is affected by the foreign substances present.

The effects of carbon are so even in well-melted ingots that 15 tempers can be selected with certainty, and skilled operators can even make this into 30 tempers.

Third.—The crystals are affected by the walls of the mould in which the liquid is cooled.

This is very marked in chilled iron, and in what the melters call scalded ingots. The effect of the wall can be noticed also in any casting.

When steel congeals, the foreign substances are driven out to some extent by sudden cooling, just as cold ice is clearer and sounder and stronger than slowly-formed ice.

In chilled iron the graphitic particles are found just at the edge of the chill; a scalded ingot looks like chilled iron, but the crystals are not hard like the crystals of a true chill, and polarized ingot would be a better name. Such ingots are weak and brittle.

There is much evidence to show the tendency to the extrusion of foreign elements as molten steel cools, of which the two cases following are given.

An ingot weighing several tons was drilled at the top and bottom, and analyses gave

	For the top.	For the bottom.
Silicon	.023	.078
Phosphorus	.014	.032
Sulphur	.023	.027
Manganese	.306	.425
Carbon	.725	.775

A large bar of steel made for rolls by Krupp, of Essen, was turned and bored, and the turnings were analysed, with the following result:

	Outer.	Inner.
Silicon	.130	.195
Phosphorus	.044	.050
Sulphur	.000	.005
Manganese	.448	.425
Copper	.234	.224
Carbon	.852	1.020

The latter case is not so marked, except in the carbon, as in the case of the ingot, yet these two cases indicate that the elements sink by gravity, and leave the surface as it cools.

In the light of the liquid theory, the above cases illustrate a reason for the well-known unequal distribution of the elements in steel.

They also point to the idea that the elements in steel are there as alloys or in solution, and not in chemical combination. It may be true that there is a definite carbide of iron in steel, yet, if there is, it is evidently there in solution.

Mr. Metcalf's experience leads him to believe that there is no property of steel which is not common to cast-iron; for instance, the hardening of steel and chilling of cast-iron, and the softening of either by heat. He believes that from the mildest steel, containing only traces of carbon, to the highest cast-iron, we have simply one substance, iron, containing various quantities of alloys or substances in solution, and that the properties which we observe vary only in degree, due to the quantity of alloy that is present.

In considering the effect of temperature on steel, Mr. Metcalf says that it is well known to all workers in steel and cast-iron, that the whole structure of the ingot or casting varies very decidedly with the temperature at which the metal is poured, and this fact is constantly made use of to produce desired results. But outside of those who have a large and varied experience with steel, it is not so generally known what a mercurial substance it is, both in volume and structure; and that in every piece of steel that is in existence to-day, there is a sure record of the last temperature to which it was subjected, as well as of the manner in which the steel was worked.

For every variation of heat which is visible to the naked eye there is a corresponding variation in structure, which is equally visible to the naked eye if the record be opened by fracturing the piece.

Professor Langley's research on the specific gravity of differently heated pieces of steel, shows that there is also a different specific gravity for each difference of structure.

This being the case, there is of necessity a permanent internal strain for every variation in specific gravity, because each change in specific gravity means, of course, a corresponding change in volume. These strains vary from the slightest up to those that produce rupture; the piece cracks.

A piece of 0.53 carbon steel will vary in specific gravity from 7.844 to 7.818, from the bar finished at ordinary red heat to the bar cooled from a scintillating heat respectively, a difference of 0.026. A bar of 1.079 carbon, under the same conditions, will vary in specific gravity from 7.825 to 7.690, a difference of 0.135.

This shows that for a double quantity of carbon we have five times the difference in specific gravity, due to an equal difference in temperature. This, the writer believes, is the "mystery" of the brittleness and the tendency to crack in high steel. If engineers who are in the habit of dealing with structural steels are disposed to think that these are both cases of high steel, he explains that these particular experiments were made on a fine grade of tool steel, and that, compared to the ordinary Bessemer and open-hearth steels, the 0.53 carbon tool steel would grade, in softness and ductility, about the same as 0.25 carbon Bessemer steel.

Experience teaches that this rule of change in volume holds good all the way through the carbon series. A piece of 0.10 carbon steel may be heated white hot and plunged into water without breaking it; but if the same piece be quenched at a red heat, and also at a white heat, in different parts, and the parts are then broken, the different grains of the pieces will present a record of temperatures which, once seen, will never be forgotten. On the other hand, if a piece of steel of 1.079 carbon be quenched at a bright orange color, it will be a very remarkable piece of steel if it does not fly to pieces.

This question brings us to the subject of annealing, a consideration of which will bring out some of the most useful and important properties of steel. Every piece of steel is at its best in all physical properties when it has been annealed, so that it is in the condition which steel-makers call refined, that is to say, when the grain is in the finest condition possible, or when its crystals are the most minute and most uniform in size.

This statement is subject to a slight modification in considering a piece of hardened steel; when steel is hardened properly the grain is slightly finer than it would have been if it had been allowed to cool slowly; but the difference is very slight, and if the hardened piece be subsequently annealed this difference disappears.

Each temper of steel refines at a different temperature.

A piece of 0.10 carbon steel will refine probably at a lemon color. A piece of 0.30 carbon steel will refine at a dark lemon or bright orange color. A piece of 1.00 carbon steel will refine at a dark orange color, or the color that is reached just as the last shades of black disappear.

As a rule, the best heat to harden at is the refining heat, and the same heat is a good guide for annealing, although the heat may be raised very slightly in annealing high steel, but it should be done with great care, and it should be lowered considerably in annealing mild steel to avoid over-annealing. It is remarkable, and probably the most important property of steel, that, no matter what the grain may be, no matter how coarse from over-heating, or how irregular from uneven heating, if it be heated uniformly to the refining heat and kept at that heat long enough, the crystals will change in size and will all become small and uniform, so that the fracture will be so even that it will be called fine-grained and amorphous. The magnifying glass will, however, reveal a crystalline structure in the most beautifully refined steel. If a piece of chilled cast-iron be kept at a bright red heat for an hour or two, the chill will not only become soft, but the long crystals will disappear altogether, and the whole piece will be ordinary-looking gray cast-iron.

If a scalded or polarized ingot be kept at a bright red heat for an hour or two, it also will lose every trace of its needle-like polarized crystals, and will become a uniform fine-grained piece of steel, and it will be as tough as if it had never been scalded and brittle.

If any ingot be annealed properly it will lose every vestige of its distinctive carbon crystallization; it will become refined and tough.

Unannealed ingots are brittle, easily broken with a

sledge, and are distinctively marked; annealed ingots are fine-grained and tough, and must be cut with a set to be broken; and when broken an effort to grade them by the fractures is the wildest guess-work, in which none but a great expert should indulge. If a well-annealed piece of steel is the best piece of steel in every respect, an over-annealed piece of steel is the very worst piece, and should always go right back into the melting furnace. Over-annealed steel is brittle, harsh, not ductile, will not harden, and will not temper, and there is no way but melting to make it good.

The time required for annealing is longer for a large than a small piece; the correct time must be arrived at by experience.

The writer then considers the question whether steel and iron crystallize in service after a long duty, and having been subjected to many repetitions of strains, vibrations and shocks. If it be true that the largest crystals and the coarsest and weakest structure are formed when iron and steel are allowed to cool slowly and in a state of rest; and if the finest crystals and the best structure can only be formed by quick cooling and the violent agitation of the hammer or of the rolls; or by careful heating to just the right temperature to cause the formation of fine crystals, it would seem somewhat anomalous to assume that this is all reversed in the cold state, and that cold iron and steel can be shaken up into coarse crystals and a weak condition.

It may be possible that such an anomaly could exist, but it seems more reasonable to suppose that when an axle or a crank-pin breaks and develops in the interior large, fiery and weak crystals, that those crystals were formed there by too much heat, too slow cooling, and too little work when the piece was formed.

It is proper to remark here that the hammering of a round piece between flat dies is a dangerous operation; it is a common thing to find round-hammered bars of steel burst in the middle for long distances, of which there is no evidence at the ends or on the surface; therefore, round pieces for structural purposes would be safer if they were hammered in swedges or rolled in grooves.

Piped ingots should be looked after too; it is quite likely that the hollow rail that broke with such disastrous results in New England lately was rolled from a piped billet.

As to the physical properties of steel, mild steel, such as is used commonly for structural purposes, is more ductile, stronger and tougher than iron; it is more easily and safely produced in large masses than iron, and when worked properly it can be put into the most difficult shapes, and be made to do good duty.

High steel is hard and brittle, and generally of great tensile strength; its use is hazardous, because of its great change of volume for a slight change of temperature; yet it can be made very ductile by careful annealing.

When steel is to be subjected to repeated deflections or alternations of strain, the mild steel is the more enduring; but when steel is to be subjected to rapid vibrations, as in a pitman or a hammer rod, a higher steel is much better than dead soft steel. In using higher steel, however, it is important to have it well annealed and perfectly smooth. Instances have been known where a break in a hammer-rod could be traced to a slight tool-mark. No sharp angles or corners should be allowed in structural steel.

A great railroad company discovered not long ago that the moduli of elasticity of mild, medium and hard steels, tempered and untempered, were practically the same. Next, it was decided that the strains in coiled springs were torsional; then the moduli of elasticity were applied to the formula for torsion, and it was discovered that if the bars were of the proper size it would make no difference how much or how little carbon they contained, nor whether they were tempered or untempered, the springs would be all right. Finally, it was specified that no spring should contain less than 0.90 carbon, and, of course, they were to be tempered. This may sound absurd, but it only proved the wisdom of the engineers; they were smart enough to test their own formula, and the result was a well-designed set of springs and an admirable specification.

Mild steel does not afford good resistance to abrasion, it is too ductile and flows too readily; the flow causes heating and increased friction, and the low tensile strength yields to the friction.

The effect of the chemical constitution of steel is very marked, and is well defined in high tool steel, but it is not so well defined in mild steel, nor in Bessemer and open-hearth steel; therefore engineers do well not to meddle with chemistry at present; but it is safe to assume, in all cases, that the nearer the steel comes to being pure iron and carbon the better it is.

It may be gathered, from what has been said that in general it is better and wiser for engineers to adhere as closely as possible to mild steel for large structures, where the material is used in comparatively large masses.

First, because it is more ductile than high steel, and therefore not so liable to break under sudden stress; and second, because it can be safely worked into shape by less skilled hands than are required in the manipulation of high steel; yet there are cases where it is wise to take advantage of the superior strength of high steel in the largest structures, of which we have notable examples in the staves of the arches of the St. Louis Bridge, and in the wire of the cables of the East River Bridge.

On the other hand, there seems to be danger in the enthusiasm of some of the admirers of mild steel, whose statements that it will stand any amount of "abuse and punishment," etc., may mislead them and others into the idea that it can be handled without even as much care as is ordinarily bestowed upon wrought-iron.

If the statements made in this paper are accepted as facts, it must be obvious that care is always necessary, especially as regards heat, and particularly uneven heating. Some instances are given to illustrate this point.

In reference to steam boilers, so far as strains are concerned, it would seem that high steel would be the best; but when we consider the daily alternations of heat and cold to which boilers are exposed, fire on one side, water on the other, and the general ignorance of physics of the men who handle them, it is obvious that mild, tough steel is the only kind that is safe, and the milder and tougher the better.

STEEL FOR GUNS.

Mr. Metcalf refers at some length to the arguments brought forward by the advocates of built-up guns, Mr. Edward Bates Dorsey and others, and says that his preceptors, Wade and Rodman, held that the qualities required in a gun were elasticity, springiness and power to resist abrasion, combined with high strength and the power to offer a uniform resistance in every direction to all of the strains to which it might be subjected.

All of these properties were reached in the highest degree possible in the material with which they had to work, and none of their guns ever failed.

If Rodman had lived, the advent of good steel in great masses would at once have been seized upon by him, and before now he would undoubtedly have cast the best and biggest, the safest and the cheapest, guns that were ever made.

Rodman was a true engineer, and it was a cardinal principle with him, that any gun had a certain number of foot-tons of work to do, whether it were to batter down an earthwork or to sink a ship; and he always claimed that the best gun was the gun that would do this work for the fewest cents per foot-ton, including in the cost the making of the gun.

The writer does not believe that a good gun could be made of dead soft steel. The bore of such a gun would enlarge from the first round; the lands of the rifling would give way under the pressure of the projectile; the vent would wear out rapidly; and altogether he would expect that after a hundred rounds such a gun would be about as symmetrical as an old battered hat.

The objection to proposed methods is: To the building-up system; to the notion that "definite shrinkage" is a practical possibility; to the idea that rings can be so shrunk together that each shall be strained to exactly its elastic limit, when, in fact, that elastic limit cannot be known; to the enormous cost of unnecessary operations,

and to the doubtful utility of the operations after they are performed.

Lieutenant Ingersoll says: "What we want with gun-steel is uniformity; but this should be a development with high rather than with low qualities, and the tendency and march of events indicate that this will be attained by: First, a more intimate chemical knowledge of steel; second, a less barbarous forging-machine than the hammer; third, annealing; fourth, oil-tempering."

As to the "first," when the departments begin to dabble in the chemistry of steel there will be no more guns made; what is needed instead is an intimate knowledge of the physics of steel.

To the "second" all will agree who know anything of the subject, and, the writer adds, we want a less barbarous forging-machine than the hydraulic press. We want no forging-machine at all; the steel can be made to forge itself by static pressure and by heat.

To the "third" there can be no objection, as there is no known way of getting improper strains out of high steel except by annealing.

The "fourth" is of doubtful utility. It is not probable that the benefit derived, if there be any, can compensate for the cost, especially when we reflect that the parts are annealed subsequently. What is the object of the annealing? Mr. Davenport answers that as follows:

"It is generally admitted that the effect of tempering in oil or any other liquid is to *fix*, by rapid cooling, the amorphous conditions existing in the heated mass, thus preventing the formation of a coarsely crystalline structure, and destroying the irregular and more or less crystalline condition existing in every forging of considerable size when it leaves the hammer.

"Besides this, the molecular condition of the mass is far more uniform after treatment than before."

Thus, the writer believes, is the whole forging business effectually damned by the trusted defender of the system, whose unquestioned skill and success in this hazardous business entitle his statements to the fullest credence.

The writer then quotes at some length the experiments made by the late A. L. Holley, and his statements as to the cost of steel and iron guns in 1865, and gives the arguments for the Rodman gun as follows:

"For the information of any who may not know, I will say that the Rodman plan consists in casting a gun on end, breech down, with a hollow core. Water is circulated through the core to cool the interior rapidly, and a strong fire is kept in the pit to keep the exterior of the gun warm, thus forcing the metal to contract all in one direction and on the interior. The operation is so simple, so easy, so sure, and so scientific, that it is beyond criticism, and it would seem superfluous to add any further arguments than those given in the early pages of this paper, to make clear the possibilities of this process, properly applied, to steel. There are plants in the country now which only require the addition of some pits and molds to prepare for the casting of 40-ton guns for trial; and the extension of these plants to the casting of 100-ton or 150-ton guns would cost but a comparative trifle.

"The cost of one huge hammer, or one hydraulic plant, would build a half-dozen casting plants.

"Splendid steel castings up to 30 and 40 tons weight can be bought now for less than 6 cents a pound, while we are told to think of 40 cents a pound as the price of rough-bored, rough-turned, annealed, oil-tempered and annealed gun parts. My own opinion is that 40 cents a pound is not a high price for such work.

"To this price must be added probably 40 cents a pound more for the cost of finishing these much treated parts; this brings us very close to the figure given for the Krupp gun."

Steel-makers are invited to put up large plants for making gun parts; but such plants would have no commercial value, and would be useless when the appropriations for heavy guns of this class ceased.

Mr. Metcalf believes the built-up gun to be unscientific and unmechanical, and suggests that before going to enormous expense to provide plants and to build such guns, it would be wise to spend $200,000 or $300,000 to test the Rodman plan applied to steel.

The paper concludes as follows:

"For ready reference for the use of engineers, the statements made may be summarized as follows:

"Iron and all metals are liquids.

"Cold steel is congealed iron, containing in solution various ingredients, which give to it certain marked properties.

"Heat is the power which gives to steel all of its good and all of its bad conditions.

"Steel is as mercurial in structure and volume as mercury is in volume.

"Slow, quiet cooling from a high temperature causes the formation of large, irregular crystals, and renders the steel weak.

"Quick cooling and agitation form small, uniform crystals and a strong condition.

"The application of heat alone will change the form and the size of the crystals.

"The change of volume due to a unit of heat increases as the content of carbon increases; therefore high carbon steel must be handled with exceeding care.

"The temperature to which it was last subjected, moderated by its subsequent treatment, is always recorded in the structure of steel, and may be read there if the piece be fractured.

"Annealing, making soft, ductile and uniform in texture, is the most important of all operations from an engineer's point of view.

"Steel being crystalline, has no fiber; therefore there should be no sharp angles, no sharp edges, and no unfilleted corners; the surfaces should be smooth and free from tool marks or indentations caused by sledge blows and the like.

"With our present knowledge, the *best steel* for structural purposes is that which is most nearly composed of iron and carbon.

"Finally, good steel, properly worked, is the most useful of all of man's productions, and it may always be relied upon to do its full work to its utmost limit; but if the laws of its being be violated, it will as certainly respond, causing disappointment and disaster."

The New Naval Vessels Authorized.

(From the *Army and Navy Journal*.)

We find that there is a great lack of exact information as to what has been done by Congress for the increase of the navy. To make this clear we give here a table showing what vessels have been authorized, their size, proposed armament, cost, speed and present status. This will give a clear idea of the number and character of the vessels constituting our new navy, the last of which should be in commission by 1890.

The total sum thus far allowed by Congress for the new navy is, it will be observed, nearly $31,000,000. Of this a little over $3,000,000 is provided for guns, and a little over $4,000,000 for armor. This is over $7,000,000 in all; a sum quite sufficient to make a beginning, and to stimulate our manufacturers to exert themselves to meet the requirements of modern warfare. It should be remembered that this is but a beginning, and that no provision has thus far been made to meet the demands of the army for heavy ordnance or coast defenses. The new navy thus far authorized includes 22 vessels, of different sorts, having a total tonnage of 65,609, and armed with two 12-in. guns, twenty-six 10-in., twelve 8-in., eighty-one 6-in., the armament of two large cruisers not yet being determined. Besides this we shall have the dynamite vessel, torpedoes and Hotchkiss and Gatling guns. The appropriations for armament of the new naval vessels amount altogether to $3,075,762, as follows:

Act of July 2, 1884	$500,000	
" " March 3, 1885	84,000	
" " July 26, 1886	343,000	
" " Aug. 3, 1886	1,000,000	
" " March 3, 1887	1,128,362	
" " " " (for three steel cast guns)	20,400	
		$3,075,762

The appropriations for armor are as follows:

Act of March 3, 1885	$25,000	
" " March 3, 1887 (armor and gun steel)	4,000,000	
		$4,025,000
Add appropriations for new vessels		21,522,350
Batteries, torpedoes, etc		2,150,000
Appropriation for armament, as above		3,075,762
Total appropriation for increase of navy		$30,773,112

Name or Type.	Displacement.	Battery.	Status.	Limit of Cost.	Act.	Speed, Knots.
Chicago	4500	4 8-in. and 8 6-in.	Fitting for sea at N. Y. Yard.	$1,576,854	Aug. 5, 1862.	15
Boston	3000	2 8-in. and 6 6-in.	Not yet commis	1,031,225	Aug. 5, 1882.	13
Atlanta	3000	2 8-in. and 6 6-in.	In commission	1,031,225	Aus. 5, 1882.	13
Dolphin	150	1 6-in.	In commission	460,000	Aug. 5, 1882.	15
Charleston	3730	2 10-in. and 6 6-in.	Under contr'ct	1,100,000	Mar. 3, 1885.	18
Baltimore	4413	4 8-in. and 8 6-in.	Under contr'ct	1,500,000	Mar. 3, 1885.	19
Newark	4083	12 6-in.	To be readv'd	1,300,000	Aug. 3, 1886.	18
Gunboat 1	1700	6 6-in.	Under contr'ct	520,000	Mar. 3, 1885.	16
Gunboat 2	870	4 6-in.	Under contr'ct	275,000	Mar. 3, 1885.	13
Double-bottomed armored vessel, cruiser No. 1	6000	4 10-in. and 6 6-in.	Plans not decidedon	2,500,000	Aug. 3, 1886. Aug. 3,	17 7
Double-bottomed armored vessel, battleship No. 2	6000	2 12-in. and 6 6-in.	Plans not decidedon	2,500,000	1886. Aug. 3, 1886.	23
First-class torpedo boat	108	5 torpedoes & 2 mach. guns.	Plans not decidedon	100,000		
Puritan	6000	4 10-in.	Plans forcompletion ready but not adv't'd.	$3,178,046 for all five double-turreted monitors.	August 3, 1886.	14
Amphitrite	3815	4 10-in.	"			12
Monadnock	3815	4 10-in.	"			12
Terror	3815	4 10-in.	"			12
Miantonomoh	3815	4 10-in.	Nearly compl.			12
Dynamite Gun Cruiser (230 ft. x 26 ft.)	500	3 10½-in. dynamite guns.	Under contr'ct	350,000	Aug. 3, 1886.	20
Steel Cruiser No. 1	5000	To be determined.	Authorized.	1,500,000	Mar. 3, 1887.	19
Steel Cruiser No. 2	5000	To be determined.	Authorized.	1,500,000	Mar. 3, 1887	19
Steel Gunboat No. 1	1700	6 6-in.	Authorized.	550,000	Mar. 3, 1887.	16
Steel Gunboat No. 2	1700	6 6-in.	Authorzed.	550,000	Mar. 3, 1887.	16

There are also for "floating batteries, or rams and other naval structures to be used for coast and harbor defense," authorized by act of March 3, 1887, $2,000,000; the *Stiletto*, purchase authorized for experiment, $25,000; torpedoes for which the act of Aug. 3, 1886, appropriated $75,000 and the act of March 3, 1877, an additional $50,000.

Coast Defenses.

GENERAL H. L. ABBOTT delivered a lecture before the Academy of Sciences in New York, on the evening of March 21, a summary of which is given by the *Herald* as follows:

According to General Abbott the country needs for its coast defenses:

Heavy guns;

Armor-clad casemates;

Disappearing gun carriages in earthworks:

Heavy mortars;

Submarine mines or fixed torpedoes, and

Fish torpedoes.

The lecturer said that this nation may be attacked in four ways: First, by fleet and army combined, as in our Revolutionary War; second, by blockading the entrances to all our ports; third, by bombardment of our seaport cities from a long distance; fourth, by a fleet forcing its way into our harbors, and making a direct attack or levying tribute on our people.

The first is not now greatly to be feared. We are too distant from great powers, and too strong on land.

The second should be met by the Navy, and is, therefore, outside a discussion of coast defenses.

The third is not probable, though it may be possible. The extreme range of 10 miles for heavy guns cannot be obtained from shipboard, and as an elevation of only 15° or 16° can be given, not over 5 to 6 miles' range is attainable.

The fourth is the one which is possible, probable, even certain—if we have war before we have better defenses.

The race between guns and armor began about thirty years ago, and there has been more development in ships and guns in that time than in the two hundred preceding years. The jump has been from the 7-in. rifle as the largest piece, to the 110-ton Armstrong; in armor from 4½ in of iron, to the *Inflexible* with 22 in. of steel plating. The new Armstrong gun of 110 tons, tried only last week, with 850 pounds of powder and an 1,800 pound shot can pierce all the targets, and so far guns have the victory over armor. This gun developed 57,000 foot-tons of energy, and will probably reach 62,000. Imagine the Egyptian needle in Central Park, shod on its apex with hard steel, dropped point downward from the height of Trinity steeple; it weighs 225 tons, and it would strike with just about the effect of one of the 110-ton gun's projectiles. Two of these guns are ready for the ironclad *Benbow*, and the Italians have several equally powerful of 119 tons from Herr Krupp. The most powerful gun in the United States, the 15-in. or the 12 in. rifle, has a muzzle energy of 3,800 foot tons.

Ships like the *Inflexible* are the most powerful afloat. A steel water-tight deck extends across the ship, and she has 135 water-tight compartments. Her guns and engines amidships have a protection of 24 in. of armor, and amidships she has a citadel carrying two revolving turrets, each containing two 80-ton guns. Her turret armor is 18 in. thick. She can make 14 knots, and she has cost $3,500,000. But she has a low free-board, and the guns therefore get no plunging fire.

The French ship *Meta* has her heaviest guns mounted *en barbette*, high above the water line, giving a splendi plunging fire.

Either of these ships could enter any of our harbors and hold us at her mercy.

The entrance to the harbor of Alexandria, Egypt, is about 5 miles across. At the time of the bombardment the protecting fortifications were situated at the east end, in the center, and at the west end. On the west there were mounted 20 modern guns of great size and power, and there were 7 others at the east end.

Although the Egyptians fought bravely they did very little harm to the English fleet, while on the second day the defense was silenced altogether. Following the bombardment—as in Paris—came the reign of mob law, doing more harm than the shells had done; and it is a possibility that every such bombardment would be followed by such an overthrow—at least temporary—of all forms of law and order.

The ships that had silenced the Alexandria batteries—which had 27 heavy guns more than we have—could reach our coasts in 10 or 12 days, and we would have nothing to meet them.

Armor-clad casemates are beginning to take the place of masonry. A tremendous thickness of masonry is built up to the very embrasures for the guns in the steel-clad turrets. This (the Gruson) system has been adopted by Belgium, Holland, Germany, Austria and Italy.

In 1882 England had 434 heavy modern guns behind armored shore batteries; besides these at home, she had 92 in her colonies, of which 13 were in Halifax and 11 in Bermuda—for our express benefit.

What we have are brick and stone casemates and earthworks. A sample granite casemate, with iron-lined embrasure, was built at Fortress Monroe, and 8 shots were fired at it from a 12. in. rifle converted from an old 15. in. smooth bore. This gun develops only 3,800 foot-tons of energy—a mere nothing compared with the 62,000 foot-tons of the English and German 110-ton guns.

General Abbott showed most conclusive proof of the

worthlessness of masonry forts in pictures showing the effect of the shots. The massive 8 ft. thickness of granite was pierced and battered till it looked like a ruin. Not a man inside would have been left alive.

He also showed a "disappearing" gun in an earthwork, the gun recoiling below the level of the parapet and being run up to a firing position by a counterweight. In 1878 Congress stopped all appropriations for defenses, and nothing had been done since.

General Abbott said that we needed submarine mines or fixed torpedoes which should be thickly interspersed about the channel and be exploded by an electric battery on shore. To prevent these torpedoes from being exploded by the enemy the surface over them should be covered by plenty of guns. Heavy guns and mortars were needed to resist attacks by heavy iron-clads. Movable torpedoes were valuable, but only as an auxiliary—a very minor auxiliary—compared with submarine mines. We should be cautious not to infer that torpedoes made a satisfactory defense alone, as they must be protected by large and small guns, and they form only a part of the chain of general defenses.

The English 110-Ton Gun.

(From *Engineering*.)

For some months past visitors to the Royal Arsenal, Woolwich, may have noticed, lying near the great steam crane of the gun factories two large guns, within a fraction of 44 feet in length, and each weighing 247,795 pounds, or rather over 110½ tons. One of these pieces of ordnance—the largest ever made in this country—last week commenced its firing trials at the proof butts, under the personal supervision of Colonel Maitland, R. A., Superintendent Royal Gun Factories, and in the presence of the President and some of the members of the Ordnance Committee; Captain Andrew Noble, C. B., and of Mr. Vavasseur representing the Elswick Ordnance Company.

We shall in an early issue give illustrations of the new gun, and shall compare it with the 119-ton Krupp gun, but meanwhile we may give some leading particulars. The gun is made throughout of steel; the "A" or inner tube is made in one length from a forging supplied by Sir J. Whitworth & Co., instead of being in two parts, as in the Italian heavy guns, made also at Elswick. Over the inner tube is shrunk the breech-piece, which is supported by three layers of comparatively thin steel hoops. It will thus be seen that the whole of the metal assists in bearing the transverse strain, but the inner tube is free from any portion of the longitudinal strain, as it extends only to the "obturator;" the breech-piece takes the greatest part of that strain, but it is assisted therein by the peculiar construction and distribution of the hoops. A long hoop with stout shoulders forms the rear part of the first layer, and its front exterior shoulder engages the rear shoulder of another long hoop, which forms the front part of the second layer. Again, the "trunnion hoop" (so called) is formed and shrunk on in such a manner as to draw the long hoops of the first and second layers together; hence there is a direct pull from the trunnion hoop to the shoulder on the breech-piece. There are in reality no trunnions, the exterior of the trunnion hoop forming rings which will be held in a strong steel band attached to the gun slide in the barbette battery of the ship. To prevent the inner tube moving forward inside the breech-piece, a ring of a bronze alloy is run into a serrated recess at the front of the latter; a similar ring is used to assist friction in keeping the front of the trunnion hoop in its place.

The hoops are all so arranged as to break joint, and an ingenious plan is adopted to link together, by means of the outer one, those hoops which abut against one another. This consists of rings on the exterior and interior of the inner and outer hoops respectively, alternate portions of which rings are slotted away; the outer hoop, when heated, is passed over the inner, so that the projections left pass through the slotted intervals, and it is then turned round till the projections of one hoop engage exactly with those of the other. No longitudinal movement is now possible, and the intervals are all filled up with steel wedges, so that there can be no circumferential shift. Thus the gun is bound together from the extreme breech end to a point far up the chase.

It may be noted that, in the French heavy guns, the breech-screw engages in the inner tube itself, which thus becomes almost wholly responsible for the longitudinal strain. Again, in Krupp's great 119-ton gun the longitudinal strain is entirely taken by the end of the breech-piece, which supports the back of the wedge closing the bore; it is moreover weakened by the loading hole through its rear end.

The "obturation," or means of stopping the escape of powder gas, is peculiar to this gun. It is not the Elswick cup nor the De Bange asbestos pad, but a modification introduced by Mr. Vavasseur, wherein the mushroom-head of the De Bange pad is retained, but the asbestos is replaced by a ring of soft copper which is forced by compression, on the discharge of the gun, into close contact with the inner tube; no ring is required to be inserted inside the end of the bore.

The principal dimensions of the 110-ton gun are as follows:

Total length	524 in.
Length of bore (30 calibers)	487 in.
" rifling	397 in.
Diameter of bore	16.25 in.
" chamber	21.125 in.
Cubical capacity of chamber	28,610 cub. in.
Weight of gun	247,795 lbs.
" projectile	1,800 lbs.

The polygroove rifling commences with one turn in 120 calibers and increases to one turn in 56 calibers at the muzzle.

The gun was carried down to the proof ground, as well as fired upon, the ingenious bogie carriage—running on six pairs of steel trucks—constructed in the Royal Carriage Department, under General Close, the steel castings being supplied by Messrs. John Rogerson & Sons, Stanners Close Works, Wolsingham. It weighs 95 tons, and is so constructed that it can be altered to mount for proof all the heavy breech-loading guns from the 12-inch of 43 tons upward. The carriage is free to run back on the inclined rails, when fired, returning again to the loading point by its own weight; but the chief force of recoil is taken by the Vavasseur hydraulic buffers, the ends of the pistons being fixed on the carriage, while the cylinders are free to move with the gun slide.

It was about noon before the firing commenced, the service of the gun being very slow, owing to the operations of loading, etc., which will ultimately be performed with the greatest ease by means of hydraulic gear, having at present to be carried out with ordinary tackle by hand. The charges of powder commenced at 600 lbs. of Waltham Abbey "prism brown," commonly called "cocoa" powder; each charge was subdivided into sections of about 112 lbs. or 150 lbs. for convenience of loading, the prisms being arranged as usual in rigid hexagonal cartridges cased in silk cloth. The proof cylinders weigh 1,800 lbs., as will the service projectiles, all of which will be made of steel; the armor-piercing projectile will be of forged steel, probably made on the Firminy plan, the others being common shell and shrapnel. The report of the gun was not so loud as might have been expected, owing, probably, to the slow-burning powder used and the length of the bore, but the addition of each 100 lbs. of powder made a very appreciable difference in this respect.

The recoil of the hydraulic cylinders on the slide at the first round was about 4 ft. in addition to which the gun and carriage ran back on the inclined rails from 50 ft. to 60 ft.; in the second and third rounds the recoils on the slide were 4 ft. 9 in. and 5 ft. 6. in., and the distances traveled back on the rails 69 ft. and 77 ft. respectively. The fourth round (which was fired on Wednesday last) was fired with 850 lbs. of Westphalian powder, "Prismatic No. 1 Brown," the prisms measuring 1¼ in. from face to face and 1 inch in length. The explosion proved to be quick, and sent the powder pressure up to 18¾ tons, or 2¾ tons higher than was anticipated. The highest

service pressure is intended to be 17 tons, so that this has already been exceeded in the trials. The muzzle velocity was not increased in proportion to the pressure, and only reached 2,078 ft. per second. The recoil of the gun on its carriage was 3 ft. 3 in., the hydraulic buffer being set to a greater resistance than before, and the run on the rails was about 70 feet.

The corrected muzzle velocities and the mean pressures in powder chamber are given in Table A, below, together with the total energy at muzzle, and the energy per ton of gun—the latter proportion being a very important consideration in naval ordnance.

On the first day only one round had been fired before the men's dinner-hour, and the gun was not loaded for the second time until 3 P. M.; owing to the accurate observations which had to be taken after each shot, as well as to the slowness of manipulating such masses of metal by hand, it was nearly 5 o'clock before the firing was suspended for the day. Upon careful examination at the end of the three rounds the interior of the inner tube was found to be perfectly clean and uninjured.

It is intended to continue the experimental proof of this gun with successive charges of 900 lbs., 925 lbs. and 950 lbs., or such of them as can be fired until the intended limit of pressure in the powder chamber is reached. It is hoped that a muzzle energy bordering upon 62,000 foot-tons may be attained with the full charge. The powder charge of 850 lbs. was the largest ever hitherto fired from a gun in this country, although the Elswick 104-ton gun for the Italian Government was fired at Spezzia with some 50 lbs. more; the projectiles were virtually of the same weight, but the muzzle velocity then attained was only 11 feet per second higher than that given by the third round of the 110-ton gun with 100 lbs. less powder.

In Table B are the comparative results (so far as they are known) given by the heaviest guns in the possession of the chief European naval powers, with those already obtained from the 110-ton gun.

TABLE A.—*Showing Results of Firing 110-Ton E. O. C. Gun.*

No. of Round.	Weight of Powder Charge.	Weight of Projectile.	Muzzle Velocity.	Mean Pressures.	Total Energy at Muzzle.	Energy per Ton of Weight of Gun.
	lbs.	lbs.	feet per second.	tons per square in.	ft. tons.	ft-tons.
1	600	1800	1699	9.65	36.050	328
2	700	1800	1843	12.05	42.390	385
3	800	1800	2007	15.00	50.260	457
4	850	1800	2078	18.75	53.927	490

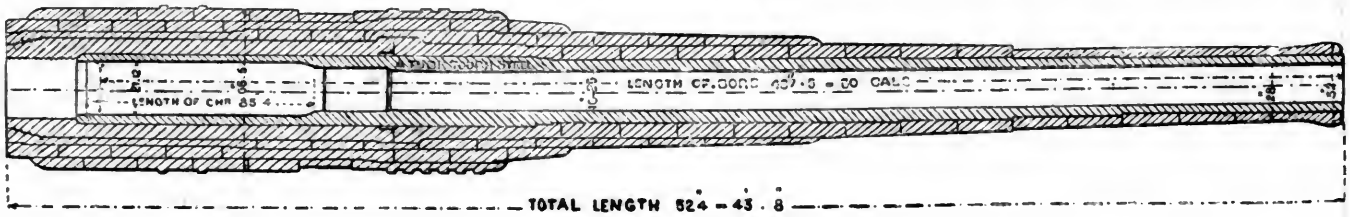
NOTE.—Round No. 3 would give a power of perforating about 30 in. of iron at 1,000 yards distance.

TABLE B.

Nature of Gun and Caliber.	Weight of Gun.	Powder Charge.	Weight of Projectile.	Muzzle Velocity.	Total Muzzle Energy.	Perforation of Iron at 1,000 Yards.	Energy per Ton of Gun.
	t'ns	lbs.	lbs.	ft. per sec'd.	foot-tons.	in.	foot t'ns
French, 37 cm. (14.56 in)........	71	546	1180	1955	31272	24.5	440
German (Krupp), 40 cm. (15.75 in.)	71	485	1715	1703	34502	23.8	486
" " " "	119	615	1632	2017	46061	29.2	387
Italian (Elswick), 43 cm. (17.00 in.)	104	899½	1799	2018	50810	29.5	488
English (R. G. F), 13.5 in.......	67*	625	1250	2050	36415	28.6	569
" Elswick 16.25 in........	110	850	1800	2078	53927	33.0	490

* The results of this gun are estimated only.

NOTE.—The Russian and Austrian guns are on the Krupp system, but ess powerful than those given above.



LONGITUDINAL SECTION.

THE NEW ENGLISH 110-TON GUN.

Table B shows the very favorable performance of the newest English gun as compared with the Krupp. The length of bore in the former is very nearly as great as in the latter, the extra length over all being necessitated by the projecting breech-piece of the Krupp system, which also accounts for a great part of the additional weight. It is to be noted, however, that the largest charge of powder hitherto fired (so far as we are aware) in the Krupp 119-ton gun is a very light one compared with that which has been fired already in the Elswick guns; also, that the heavy German gun has been ordered by the Italian Government for coast defense. We are indebted to Lord Brassey's *Naval Annual* for most of the above figures concerning foreign guns. The illustrations given herewith are a longitudinal section of the gun, and diagrams of H. M. S. *Benbow*, for which the 110-guns are intended. These show the method of barbette mounting. The central part only of the vessel is armored, and the ends of the vessel are protected by an armored deck below the water line.

Gunboats.

(From Engineering)

THE unknown and generally overrated powers of offense of the fish torpedo have given that weapon a character as an engine of destruction which recent experiments have not borne out. The silent and treacherous manner in which it would deliver its attack, together with the diabolical and complete nature of the destruction wrought, have invested it in men's minds with imaginary powers of destruction little less than supernatural. As a consequence the more honest and outspoken assaults of artillery have, by comparison, suffered in reputation for efficiency; but in the science of destruction, as in other walks of life, honesty is found to be, in the long run, the best policy, and the blow below the belt is not so favorably looked on as it was some short time ago.

Under these circumstances Sir George Elliot has chosen his time well, for advocating the more extended use of gunboats in coast-defense tactics; for, although the torpedo has never wrested from the gun its premier position, so far as large vessels were concerned, it has had things very nearly all its own way with the smaller kind of craft. The paper which the gallant Admiral read at the Royal United Service Institution last Friday had the serious defect of wandering very far from the subject matter of its title. It would, perhaps, be too much to expect Sir George Elliot to discourse for any length of time about ships without fighting over again the battle of the *Waterwitch* and the question of hydraulic propulsion. But although one may be willing to grant him the indulgence of this amiable weakness, it is taking rather a wide range to discuss our whole naval policy, both from a political and economic point of view, under cover of Gun boats for Coast Defense.

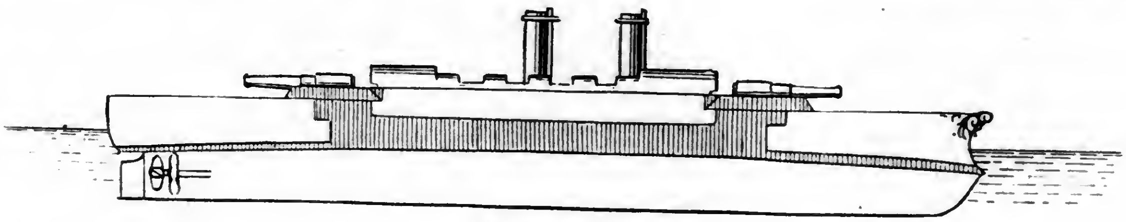
Having said this we have little but praise for the paper in question, and although the greater part of it was not germane to its title, yet the strictures of the author on political meddling in naval matters might well be read by every one of Her Majesty's subjects; more especially all those close-fisted and short-sighted tax-payers who grudge the expense of our national insurance, the chief premiums of which are the ships of the Royal Navy.

We must not, however, be led astray by the author's bad

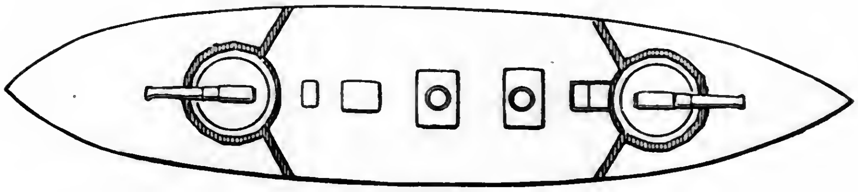
example, but will at once proceed to consider some of the most important facts respecting coast defense by gunboats, as set forth in the paper.

The author commenced by speaking of the notable services rendered by gunboats in past times, referring to James's "Naval History," and then puts the question "whether modern inventions have, in any degree, affected the essential value of this class of vessel for coast defense, either by the introduction of steam, armor-plating, submarine mining, rifled guns of greatly increased caliber, or quick-firing or machine guns, by the substitution of vessels of the *Glatton* type, by torpedo boats of various types and dimensions, or by a combination of all or any of these appliances for purposes of inshore defensive operations?" The gallant Admiral at once proceeds to answer his own question in the negative. "I am unable to perceive," he says, "that the modern gunboat has been supplanted by any of these novel features, or has lost any of its effective power for warding off attacks by bombardment at long ranges, whether by single ships or small squadrons; and, in fact, whatever advantages have been obtained on the one side, are equally applicable to the other." Indeed, Sir George goes further than this, for he says later on: "It would appear that owing to the reduced number of guns which modern ships now carry, and the swift, but completely unprotected and lightly armed. In spite of the lower cost of such craft compared to armored gunboats, Sir George Elliot stands by the latter, because the vulnerable torpedo vessels could be disabled in detail by gun-fire, as a ship at sea would naturally turn her stern to approaching torpedo boats, and keep them under fire as long as possible, and when ships are moving in the same direction, the striking range of the torpedo is almost reduced to close quarters.

The author advocated two classes of gunboats for the purposes under discussion. The first class should possess considerable speed, and would be designed to take the place of vessels of the *Glatton* type; whilst the second class would be for purely local defence where a high rate of speed would not be essential. Both classes should be armed with one very powerful armor-piercing gun, protected by a semicircular shield of stout armor-plating for end-on fighting, besides carrying a number of quick-firing and machine guns for defence against torpedo boats. The first class should have two military masts. The smaller vessels, roughly of about 800 tons displacement, would work in close vicinity to the land, and would not require a speed above 12 knots. Their tactics would be to advance a few thousand yards from the shore, and always retire if pursued. The larger class would be about double



ELEVATION.



PLAN

H. M. S. "BENBOW," ARMED WITH 110-TON GUNS.

long ranges at which the stoutest ships are now penetrable by guns which can be mounted in gunboats, and with the introduction of the latest invention of shell projectiles, that the gunboat of the future has rather gained than lost."

Armor-clad ships may be less vulnerable than the old wooden vessels, but the same remark applies, as the author pointed out, to shield-protected gunboats fighting end-on, and the smaller object will still retain its distinct advantages. Sir George Elliot would not, however, wish to disparage the value of shore batteries, submarine mines, or torpedo boats, but thinks that these means of defence would prove inoperative in the absence of assistance from gunboats, so far at least as preventing the bombardment of many of our seaport towns from distances of four to five miles.

The question, like all others of national defence, is based on expenditure. How to get most for our money is what must guide our decisions. This the author fully recognizes, and upholds his position chiefly on the score of economy. It has been contended that an outlay on additional warships equal to that demanded for gunboats stationed round the coast, would give a more efficient means of protection. This opinion, Sir George acknowledges, presents itself with a certain amount of force at first sight, but even if true in some respects, there is always the fatal objection that powerful seagoing ships might be enticed away, and they would not possess the advantages, for inshore fighting, of shallow draught. Sir Andrew Clark advocates seagoing torpedo vessels, very the size and mount a 12-in. breech-loader, 43-ton gun. They would be stationed at different ports, ready to concentrate at any point threatened. The vessels would operate as widely as safety would permit, so as to operate if possible from opposite directions of fire, and thus obtain a broadside attack.

The problem of manning such craft led to some remarks on the naval volunteer question; but without following the author and other naval officers, who spoke afterwards, it may be sufficient to say that this body has evidently won the high esteem of the regular service by the efficiency and zeal they have displayed under somewhat discouraging conditions, due principally to want of an adequate chance of learning their duties.

The discussion which followed the paper was not worthy of the occasion or the Institution. The subject is so essential a one for the service, that one might have hoped naval officers would have attended, in order to give their views and help those who have the settling of such matters to form an opinion as to the soundness of the author's contentions. As a matter of fact, there was little, if anything, said of a critical nature, so far as the ostensible object of the meeting was concerned; the old dreary controversy on hydraulic propulsion, with all the stock arguments hashed up afresh, occupying the greater part of the time. The one bright feature in the discussion was the admirable manner in which the Chairman, Admiral Sir E. Fanshawe, carried out his duties.

Modern War Ships.

The report of the lecture on this subject, which was published in the last number of the JOURNAL, did not give some very interesting tables which have been published in *Industries*, and which are given below. To make their significance understood, the abstract of the lecture given by our cotemporary is reprinted, although most of it was contained in the report which was published last month:

In 1859 the Admiralty were forced to action by the French, whose navy, under the skillful superintendence of M. Dupuy de Lome, had outstripped our own. In that year 17 line-of-battle ships and 10 frigates were fitted with engines and propellers; but the enormous sums expended on these conversions were practically wasted, owing to the shattering effect of shell on wooden ships, and in 1861 a new type was inaugurated by the construction of the *Warrior* and *Minotaur*. At first the struggle between attack and defense was practically limited to one between guns and armor; ramming—the other mode of attack—exercised but little influence on ships' designs, as it only necessitated stronger and differently shaped bows and water-tight compartments. By the 4½-in. armor of the *Warrior* the defense scored a victory; but this did not last long, and at the present day the power of the guns, in comparison with the resistance of the armor-plating, is greater than it has ever been before. In illustration of this, Mr. White referred to the figures in the accompanying table respecting English naval guns.

MUZZLE-LOADING GUNS.

	68 pr.	*110pr.	6½ ton.	12 ton.	18 ton.	25 ton.	35 ton.	38 ton.	80 ton.
Extreme length	10 ft.	10 ft.	11 ft.	13 ft.	15 ft.	15 ft.	16 ft. 3 in.	18 ft. 7 in.	26 ft. 9 in.
Caliber, inches	8	7	7	9	10	11	12	12½	16
Powder charge, lbs	16	12	30	50	70	85	140	210	450
Weight of projectile, lbs	68	110	115	256	410	548	714	820	1700
Energy at 1000 yds. in foot-tons	452	...	1280	2840	4400	5840	8050	11900	26370
Penetration of unbacked wrought-iron at 1000 yds	...	5 in.	7.3 in.	9.9 in.	11.7 in.	13 in.	14.6 in.	17.7 in.	23 in.

* Armstrong breech-loader.

BREECH-LOADING GUNS.

	2 ton.	5 ton.	14 ton.	22 ton.	45 ton.	67 ton.	110 ton.
Extreme length	11 ft. 7in.	14 ft. 5½ in.	21 ft. 2½ in.	25 ft. 10 in.	27 ft. 4½ in.	36 ft. 1 in.	43 ft.
Caliber, inches	5	6	8	9.2	12	13½	16¼
Powder charge, lbs	16	55	115	175	315	520	900
Weight of projectile, lbs	50	100	210	380	710	1250	1800
Energy at 1000 yds in foot-tons	735	2120	5580	9310	18150	29500	54000
Penetration of unbacked wrought-iron at 1000 yds	6.7 in.	10.9 in.	15.5 in.	18.4 in.	22.5 in.	27 ft. 2 in.	35 in.

Between 1859–73 the most notable changes in ship designs were due to the desire to secure fewer and heavier guns, and thick armor on as restricted a surface as possible. Thus the *Warrior* had her ends unarmored, and, though bearing 40 guns, could not sweep the horizon, and to obviate this disadvantage the *Minotaur* was armored from end to end. To avoid the addition of the extra 1,800 tons of 5½-in. armor, necessitated by this plan, the *Bellerophon* and *Hercules* were built on the "belt and battery" system, in which 12 and 14 guns respectively were carried in a box battery amidships, with outlying armored batteries at bow and stern. The *Devastation* followed, in 1869, on the "breastwork monitor type," with a low freeboard, armored from end to end in the region of the water-line, and bearing two 35-ton guns, in a central revolving turret. With the *Inflexible* the "central citadel's" principle was introduced, in which, the ends being unarmored, 24 in. armor was secured for the citadel, the four 80-ton guns in which could sweep the whole horizon. But here the high-water mark of "concentration" had been reached, and a reaction, headed by the French, and supported by the Italians, soon set in. To take advantage of the special weakness in our low freeboard ships, the French mounted their heavy guns *en barbette* high above the water, and associated with them many lighter guns. In the *Italia* and *Lepanto* the Italians followed the same plan, and mounted their four 100-ton guns 20 ft. higher above the water than the turret guns in our low freboard vessels. To meet these the *Admiral* class was designed in 1880, in which the key of the design consists

	Warrior.	Minotaur.	Bellerophon.	Hercules.	Devastation.	Dread-nought.	Inflexible.	Colossus.	Colling-wood.	Benbow.	Camper-down.	Trafalgar.
Date of design	1859	1861	1863	1866	1869	1872	1874	1878	1880	1882	1882	1885
Length of ship in feet	380	400	300	325	285	320	320	325	325	330	330	345
Breadth of ship	58 3	59 3	56	59	62 3	63 10	75	68	68	68 6	68 6	73
Load displacement in tons	8820	10280	7270	8680	9300	10820	11880	9150	9150	10000	10000	11940
I. H. P.	5500	6900	6500	8500	6600	8000	8000	7000	9600	11500	11500	12000
Speed in knots at load displacement	14.4	14.3	14.1	14.7	13.8	14.2	13.7	15.4	16.7	17.0	17.0	16.5
Number of guns	40	50	14	12	4	4	4	9	10	12	10	12
Heaviest gun	110 pr.*	110 pr.*	12 ton R.M.L.	18 ton R.M.L.	35 ton R.M.L.	38 ton R.M.L.	80 ton R.M.L.	45 ton B. L.	45 ton B. L.	110 ton E. L.	67 ton B. I.	67 ton B. L.
Caliber of gun in inches	7	7	9	10	12	12½	16	12	12	16½	13½	13½
Powder charge, lbs	12	12	50	70	140	130	450	315	315	900	520	520
Weight of projectile, lbs	110	110	256	410	714	820	1700	714	714	1800	1250	1250
Total weight of armor, tons	980	1780	1090	1340	2540	3260	3280	2410	2520	2900	2940	4230
Weight of horizontal armor in decks, glacis plates, etc	Nil.	Nil.	Nil.	Nil.	560	680	970	790	905	1155	1135	1040
Greatest thickness of side armor	4½	5½	6	9	12	14	24	18	18	18	18	20
Ratio.—Total weight of armor. Displacement of ship	.111	.173	.151	.154	.278	.296	.272	.263	.275	.290	.294	.352

* Armstrong.

of the principle of "distribution" of the main armament instead of concentration, and the association therewith of a powerful secondary battery. The following table further enforces the justice of the generalization that the gun is the most influential factor in modern war-ship design:

The lecturer then referred to the difficulty of supporting the enormous weights of these turrets, which, in the *Renown*, will be a movable weight of 850 tons concentrated on a circle 36 ft. in diameter, and surrounded by a redoubt weighing about 800 tons. In the *Italia* and *Lepanto* the barbette gun mountings, carried to a height of 33 ft. above water, weigh more than 2,000 tons. After predicting a great future for quick-firing guns, the speaker called attention to torpedo-boats, and said he thought in future none would be built between the 70-ft. launches that can be hauled on board, and those of the *Archer* and *Scout* classes of over 1,300 tons. Mr. White then referred to the elaborate fittings in first-class modern war-ships, and pointed out that they are provided with from 80 to 100 separate water-tight compartments, 31 hydraulic engines, and 45 auxiliary steam engines. Attention was next directed to the greatly increased speed recently attained. From 1859 to 1875, 14 knots was almost a standard speed for large ships; but now vessels of 13,800 tons run at 18 knots, cruisers at 18 to 20 knots, and torpedo craft at 19 to 25 knots. The lecturer then referred to the cost of war-ships, which had steadily risen from £70,000 for a 100-gun line-of-battle ship to £375,000 for the *Warrior*, £480,000 for the *Minotaur*, £360,000 for the *Devastation*, £620,000 for the *Dreadnought*, and £810,000 for the *Inflexible*. In the last mentioned the armor-plating cost £170,000, the propelling machinery £126,000, and the hydraulic gun-mounting and auxiliary engines £55,000. The *Benbow* and the *Renown* are each estimated to cost about £720,000, and the *Trafalgar* and *Nile* £860,000 each. To illustrate the ever-increasing difficulty of attaining higher speeds, the above table was given.

	Ironclad, 10,000 tons.		Cruisers.			
			3300 tons.		1500 tons.	
I. H. P.	Speed.	Increase of speed for 1000 i. h. p.	Speed.	Increase of speed for 1000 i. h. p.	Speed.	Increase of speed for 1000 i. h. p.
1000	8.3	...				
2000	10.6	2.3				
3000	12.0	1.4				
4000	13.3	1.3	10.4	...	12	...
5000	14.2	.9	13.0	2.6	14.8	2.8
6000	14.9	.7	14.6	1.6	16.3	1.5
7000	15.4	.5	15.8	1.2	17.2	.9
8000	15.8	.4	16.7	.9	17.9	.7
9000	16.15	.35	17.5	.8	18.4	.5
10,000	16.45	.3				
11,000	16.75	.3				
12,000	1.70	.25				

The Power Required to Move Slide-Valves.

[Paper Read at the Chicago Meeting of the American Society of Mechanical Engineers, by Mr. C. M. Giddings, Massillon, Ohio.]

THE investigation as to the amount of power required to move slide-valves has been, like most all mechanical researches, a matter of slow growth. The writer has sought in vain for this desirable information in many of the best authorities on steam engineering, and has found only various and elaborate deductions on a purely theoretical basis on the one hand, or else the individual opinion of over-sanguine inventors of slide-valves on the other hand, whose opinions, by the way, were entirely unsupported by tangible facts or experimental data of any kind. He determined, therefore, some time since, to enter the field of experimental research, with a view of finding, if possible, just how much power was consumed in moving the slide-valves of different engines, and how much that power varied under different working conditions; such as variations of speed and pressure, changes of load and variation in point of cut-off.

The first attempt of an experimental nature resulted in the device illustrated in fig. 1, which clearly shows the construction. Water or oil used on either side of the piston to transfer the pressure through a stop-cock to the indicator for recording in the usual manner. After having used this, it was learned that a similar device was tried by Dean Bros., the pump-makers of Indianapolis, but without success. This device was first intended to be used with a pressure gauge, but at the suggestion of Mr. Harris Tabor, an indicator was put on to register the variations of pressure in the cylinder, but the leakage past the indicator piston from the continued action of the engine soon produced a displacement which distorted the action of the valve and reduced the travel. The indicator was then displaced by a diaphragm gauge of low pressure, which had the end of the index sharpened and turned at right angles to the dial. The glass having been removed, this gauge was screwed in the cylinder where a stop-cock is now shown, and a stationary rest provided to support the slide, which carried a smoked glass. This was provided to avoid the friction of a pencil on paper, and when the glass was brought in conact with the vibrating point of the index, it described an outline on the glass which was easily preserved by blue printing, and could be made to

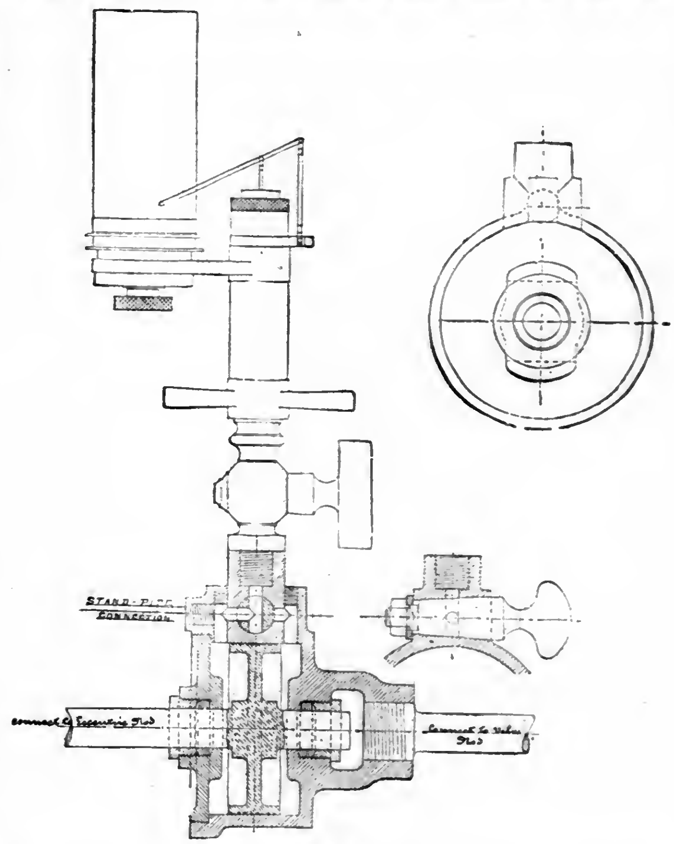


Fig. 1.

show fairly well the relative power required to move the valve under varying loads. These cards were found to be unworthy of entire confidence, for various reasons. The movement of the index was radial instead of rectilinear, and developed considerable momentum; one-half of the stroke only could be taken at once, and in spite of all precautions displacement would soon show its effects in reducing the travel of the valve when running at rated speed. However imperfect this device and its results, it was a decided step in advance of previous experiments. Having thus found the desirable feature for a valve dynamometer, it was determined to design and construct one which should possess as many of these points as possible.

1. It must be sufficiently yielding to feel the variations of strains on the valve stem, and at the same time so nearly rigid that it would give a very small fraction less than the full travel of the valve as the showing, from a reduced travel or a distorted value action, would be entirely unsatisfactory. In other words, it must be rigid without being entirely rigid.

2. It must show accurately the strains on the valve stem

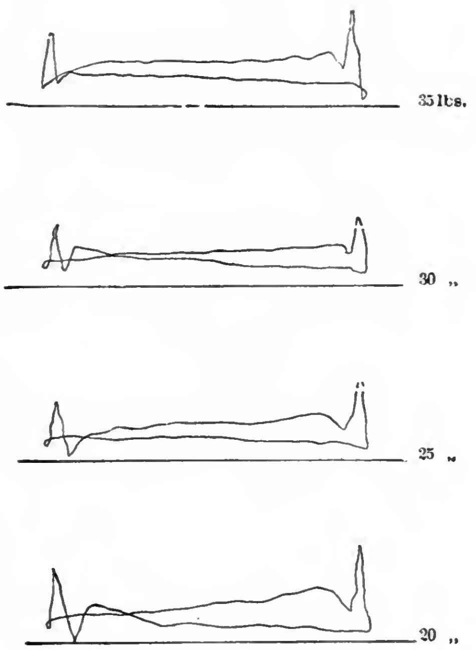


Fig. 2.

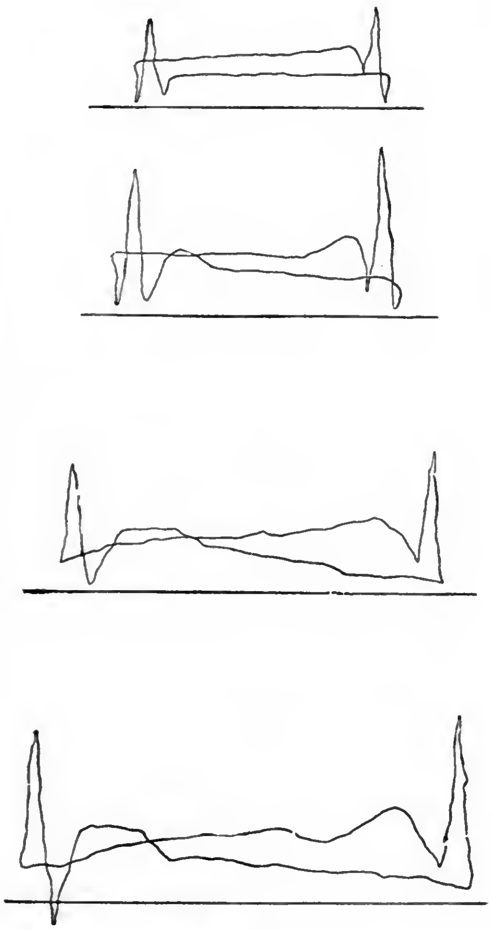


Fig. 3.

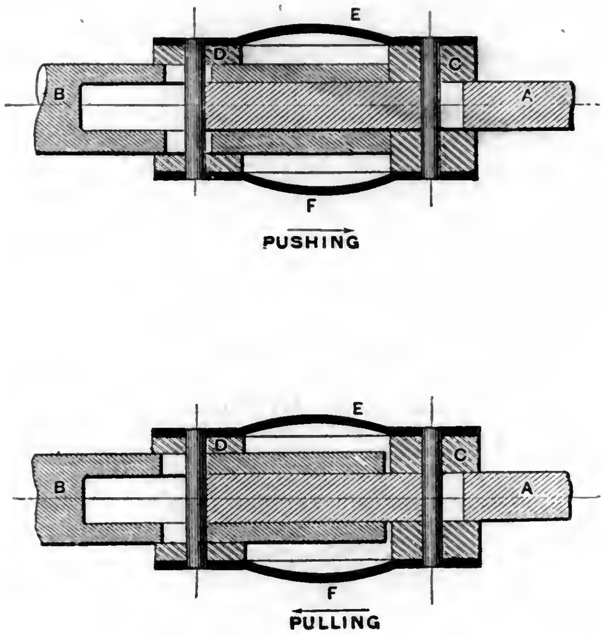


Fig. 4.

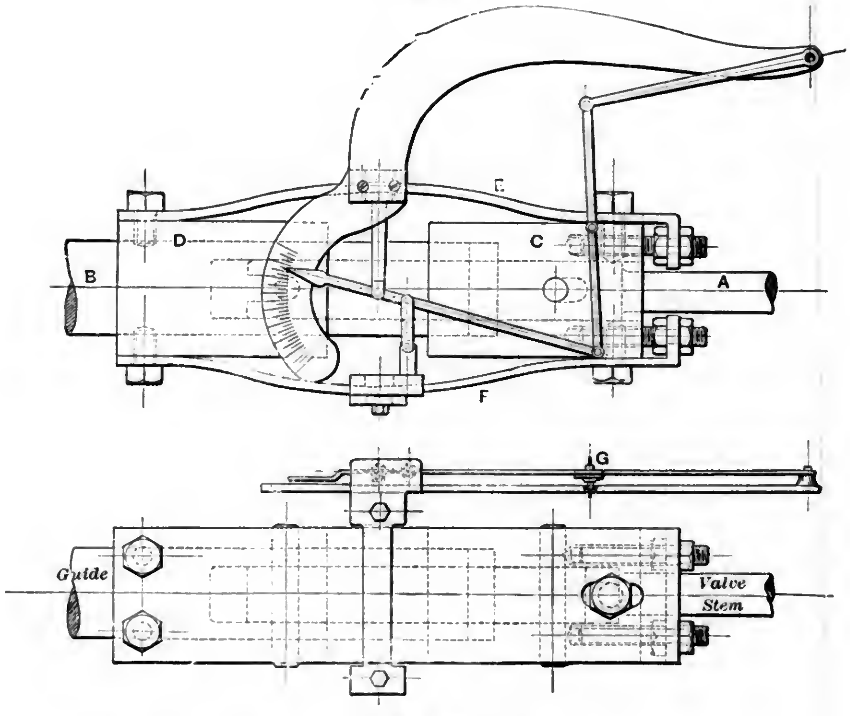


Fig. 5.

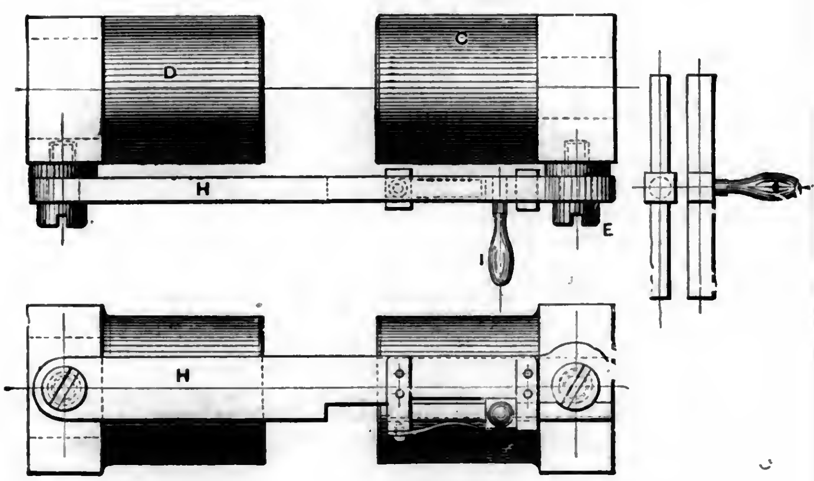


Fig. 6.

throughout the entire revolution of the eccentric, and *not simply* for one stroke of the valve. This, it is readily seen, would reverse the strains on the instrument.

3. It must have an accurate means of recording the variations of stress on the instrument, upon paper, for future calculations and comparisons of different valves.

4. It must be provided with a rigid connection to relieve the springs when not taking a card, with means to detach the same readily when under motion.

5. It must either have means of varying the tension of the springs for different size and type of valves, or be so constructed that the springs could be easily replaced with others of different tension.

The instrument designed to fill these requirements is shown in fig. 5. Fig. 4 shows in section the mechanical principles involved in the device, in which *E* and *F* are elliptical springs attached at their extremities to the sliding sleeves *C* and *D*. The former is the valve-stem guide to which the eccentric rod is attached, and the latter is the stem itself. To each spring suitable attachments are made for connecting the pivoted extremities of the parallel motion which carries the pencil *G*. A slide having suitable support was provided, which worked between grooves having an adjustable stop, so that the paper, mounted on the slide, could be brought in proper contact with the pencil and the stop properly adjusted. Then, in order to take a card, it is simply necessary to bring the paper in contact with the moving pencil during one complete revolution of the engine. A flat-pointed brass wire was attached to the instrument, so that when the paper was brought in contact with the pencil, this point would mark the neutral line, or line of *no* strain on the card, from which all measurements were taken.

It was a comparatively easy matter to design an instrument which would show the *pull* required by the valve, but when it came to showing the *push* required in the same instrument, it was quite another thing. Of course, it was impracticable to push on the ends of the springs, consequently the strain must be taken by the springs on the *pull* through *both* strokes of the valve. How this was done can best be shown by referring to fig. 4, in which corresponding letters refer to corresponding parts in fig. 5. *D* is a sleeve, sliding loose upon the valve-stem guide *B*, and attached to the springs; *C* is the sleeve sliding loose upon the valve-stem *A*. Each of the sleeves has a steel pin fixed in the sleeve, and passing through slots in the center of the valve stem and valve-stem guide respectively. It will be noticed that the valve-stem guide *B* comes to a bearing against the sleeve *C*; also that the valve stem *A* comes to a bearing against the pin in the sleeve *D*. When in operation the valve-stem guide first pulls the sleeve *D* by means of the pin, thence the strain is transferred through the springs to the sleeve *C*, which pulls the valve stem by means of its pin, as shown. But when it comes to the push part of the stroke, the valve-stem guide *B* first pushes against the sleeve *C* without moving the valve stem, thence the strain goes back through the springs to the sleeve *D*, which pushes on the end of the valve stem by means of its pin, and so moves the valve. Thus the strain always goes through the springs on the pull, and is then measured and recorded by the instrument.

The rigid connection shown in fig. 6 consists simply of the bar *H* hinged to the sleeve *D* and hooking over a post *E* on the sleeve *C*, and having a sliding catch *I* to hold it either on or off the post *E*. When this connection was locked in position, it was intended that there should be no movement of the pencil, but, owing to the spring of the parts, the pencil did move so that it could not be used to draw the neutral line. It was found that springs of this kind could be made stiff enough to move the valve without permitting any appreciable reduction of the stroke, and at the same time would be elastic enough to feel the slight variations of the strain, and produce sufficient movement when multiplied by means of the levers to make a good card. But this same quality prevented adjusting the springs equally for valves of different size, and it was decided to use springs of different thickness to meet this case.

A scale by which to measure the cards taken by the various springs was easily constructed by the use of a spring scale known to be accurate, and noting the movement of pencil for each 50 lbs. strain added to the dynamometer.

In computing these cards, the height gives the maximum, minimum and average strain on the valve stem in lbs. This, multiplied by the rate of movement gives the foot lbs. of work done to move the valve. In using this instrument, it was found that high speed produced fluctutuations in the card, especially if the springs were too light for the valve, but with the proper strength of spring a speed of 250 revolutions per minute was entirely feasible. Fig. 2 shows cards taken with varying loads, and fig. 3 shows cards taken from varying points of cut-off. All cards taken with any considerable load invariably show one end (and that always the same end) heavier than the other. The cause of this for a time was a mystery, but was fully and satisfactorily explained by taking into consideration the area of the valve stem, which, multiplied by the pressure in the steam chest, worked against the instrument in one-half of the stroke and with it in the other half, making the difference in strain equal to the sum of the pressures. A table is appended which gives both the total power required to move a special type of equilibrium slide valve; also the percentage of the whole power of the engine which was absorbed by the valve. The comparative tables from different valves which are given herewith may perhaps be found instructive.

6¾″ BY 10″ ENGINE.

Revolutions.	Load on Brake, lbs.	H. P. to Move Valve.	Power Developed on Brake.	Per cent. of Power Developed on Valve Stem.
125	10 lbs.	$\frac{1}{16}$ H. P.	3 H. P.	2 per cent.
175	30 "	$\frac{1}{8}$ "	9 "	1.2 "
200	40 "	$\frac{1}{5}$ "	13.5 "	1.4 "

9″ BY 12″ ENGINE. 100 Rev. 3 PORTED FLAT VALVE.		9″ BY 14″ ENGINE. 100 REV. EQUILIBRIUM VALVE.	
Brake Load on Engine.	Percentage of Load on Valve Stem.	Brake Load on Engine.	Percentage of Load on Valve Stem.
5.5 H. P.	4½ per cent.	11.4 H. P.	1.2 per cent.
7 "	3½ "	13.5 "	1.1 "
8.25 "	4 "	14. "	1 "
8.9 "	6 "	15.6 "	1 "
11.1 "	7.3 "		

Standard Pipe and Pipe-Threads.

[From the *Stevens Indicator*, published at the Stevens Institute, Hoboken, N. J.]

THE chaotic state in which the matter of standard pipe-threads has been for years, both here and abroad, has finally had the effect of arousing American engineers at least to vigorous action. As a result the whole subject has been thoroughly overhauled by a committee appointed somewhat over a year ago by the American Society of Mechanical Engineers, in conjunction with committees of United States manufacturers of wrought-iron and boiler tubes, and brass and cast-iron fittings. The outcome of their work was embodied in an exceedingly interesting report submitted to the American Society of Mechanical Engineers at their last annual meeting (November 29–December 3, 1886), and which has just been issued in pamphlet form.

Without going into all the details which it was desirable to give in this report, it will suffice for our purpose to note that after an endless amount of correspondence, a large number of committee meetings, and the examination and test of many samples of threaded pipe, the several as-

sociations of manufacturers resolved to adopt and adhere to the original Briggs standard of gauges. Comprehensive information regarding the subject of standard pipe and pipe-threads as applied in American practice is given in the Excerpt Minutes of *Proceedings* of the British Institution of Civil Engineers (session 1882-83, Part I), containing the paper of the late Robert Briggs on American Practice in Warming Buildings by Steam. Referring specially, however, to the matter here considered, we take from the report before us the following, from the text and tables of Mr. Briggs's paper, giving completely the date upon which the Briggs standard pipe-thread sizes are based:

The taper employed for the conical tube-ends is uniform with all makers of tubes or fittings, namely, an inclination of 1 in 32 to the axis. Custom has established also a peculiar length of screwed end for each different diameter of tube. Tubes of the several diameters are kept in stock by manufacturers and merchants, and form the basis of a regular trade in the apparatus for warming by steam. The ruling dimension in wrought-iron tube work is the external diameter of certain nominal sizes which are designated roughly according to their internal diameter. These nominal sizes were mainly established in the English tube trade between 1820 and 1840, and certain pitches of screw-thread were then adopted for them, the coarseness of the pitch varying roughly with the diameter, but in an arbitrary way utterly devoid of regularity. The length of the screwed portion on the tube end varies with the external diameter of the tube according to an arbitrary rule-of-thumb; whence results for each size of tube a certain minimum thickness of metal at the outer extremity of the tapering screwed tube-end. It is the determination of this minimum thickness of metal for the tapering screwed end of wrought-iron tube which constitutes the question of mechanical interest.

For a tapering tube-end for a nominal 2½ in. tube—that is, a tube of about 2½ in. internal diameter and 2⅞ in. actual external diameter, the following particulars are given: The thread employed has an angle of 60°; it is slightly rounded off both at the top and at the bottom, so that the height or depth of the thread, instead of being exactly equal to the pitch, is only four-fifths of the pitch or equal to $(0.8)\frac{1}{n}$, if n be the number of threads per inch. For the length of tube-end throughout which the screw-thread continues perfect, the empirical formula used is $(0.8\,D \times 4.8 \times \frac{1}{n}$ where D is the actual external diameter of the tube throughout its parallel length, and is expressed in inches. Further back, beyond the perfect threads, come two having the same taper at the bottom, but imperfect at the top. The remaining imperfect portion of the screw-thread furthest back from the extremity of the tube is not essential in any way to this system of joint, and its imperfection is simply incidental to the process of cutting the thread at a single operation. From the foregoing it follows that, at the very extremity of the tube, the diameter of the bottom of the thread is,

$$D-\left[\frac{2\times(0.8\,D+4.8)}{32\,n}+\frac{2\times 0.8}{n}\right]=D-(0.05\,D+1.9)\times\frac{1}{n}$$

The thickness of iron below the bottom of the thread, at the tube extremity, is empirically taken to be $=0.0175\,D+0.025$. Hence the actual internal diameter d of any tube is found to be in inches,

$$d=D-(0.05\,D+1.9)\times\frac{1}{n}-2\times(0.0175\,D+0.025.)$$

or

$$d=0.965\,D-0.05\frac{D}{n}-\frac{1.9}{n}-0.05.$$

For the various sizes of tubes, ranging from ⅛ in. to 10 in. nominal internal diameter, with their corresponding numbers of screw-threads per inch, the actual internal diameter d is expressed by the following Table I in terms of the actual external diameter D.

Table I.—Diameters of Wrought-Iron Welded Tubes.

Nominal internal diameter of tube. Inches.	No. of screw threads per in. No.	Actual internal diameter d in terms of actual external diameter D. Inches.
⅛	27	$d = 0.9631\,D - 0.1204$
¼ and ⅜	18	$d = 0.9622\,D - 0.1556$
½ and ¾	14	$d = 0.9614\,D - 0.1887$
1, 1¼, 1½ and 2	11½	$d = 0.9607\,D - 0.2152$
2½ to 10	8	$d = 0.9587\,D - 0.2875$

The figures derived from this statement, which are of importance for practical use, are presented in detail in Table II in a convenient order for reference.

The number of screw-threads per inch for the several sizes of tubes is here accepted from customary usage. It is the workman's approximation of the pitch practically desired, and much reluctance must consequently be felt in calling it into question. Still it would have been better to investigate the general case upon the basis of a pitch ranging in closer accordance with the range of tube diameter. Thus the nominal ½-in. tubes might have had 16 threads per inch; ¾-in. 14 threads; 1 and 1¼-in. 12 threads; 1½ and 2-in. 11 threads; 2½ to 3½-in. 10 threads; 4 to 6-in. 8 threads; 7 to 9-in. 7 threads, and 10-in. not more than 6 threads per inch. The existing number of threads, however, as given in Tables I and II, are now too well established to be disturbed; at all events they must be taken in any statement of present practice.

Table II.—Standard Dimensions of Wrought-Iron Welded Tubes.

	Diameter of tube.			Screwed ends.	
Nominal inside.	Actual inside.	Actual outside.	Thickness of Metal.	Number of threads per in.	Length of perfect screw.
Inches	Inches	Inches	Inches	No.	Inches.
⅛	0.270	0.405	0.068	27	0.19
¼	0.364	0.540	0.088	18	0.29
⅜	0.494	0.675	0.091	18	0.30
½	0.623	0.840	0.109	14	039
¾	0.824	1.050	0.113	14	0.40
1	1.048	1.315	0.134	11½	0.51
1¼	1.380	1.660	0.140	11½	0.54
1½	1.610	1.900	0.145	11½	0.55
2	2.067	2.375	0.154	11½	0.58
2½	2.468	2.875	0.204	8	0.89
3	3.067	3.500	0 217	8	0 95
3½	3.548	4.000	0.226	8	1.00
4	4.026	4.500	0.237	8	1.05
4½	4.508	5.000	0.246	8	1.10
5	5.045	5.563	0.259	8	1.16
6	6.065	6.625	0.280	8	1.26
7	7.023	7.625	0.391	8	1.36
8	8.982	8.625	0.322	8	1.46
9	9.000	9.688	0.344	8	1.57
10	10.019	10.750	0.336	8	1.68

Taper of conical tube ends, 1 in 32 to axis of tube.

Revised Regulations for Steamboat Inspection.

At the recent annual meeting of the Board of Supervising Inspectors of Steam Vessels some changes were made in the rules governing inspections.

The following new paragraph was added to Rule II., Section 9: "Provided, however, that all lap-welded flues 16 in. diameter and not less than 7 in. diameter, when used under a steam presssure of 120 lbs. and upwards, shall be of the same thickness as prescribed in Table, Rule II., Section 8, for riveted flues."

Rule V., Section 5, is amended to read as follows: "No person shall receive an original license as engineer or assistant engineer, except for special license on small pleasure steamers, who has not served at least three years in the engineer's department of a steam vessel; provided, that any person who has served a period of three years as a locomotive or a stationary engineer, or as a regular machinist in steam-engine works at least three years, may be licensed to serve as engineer on steam vessels after having not less than one year's experience in the engine

department of a steam vessel of 20 tons or upward (which fact must be verified by the certificate, in writing, of the licensed engineer or master under whom the applicant has served), and no person shall receive license as above, except for special license, who is not able to determine the weight necessary to be placed on the lever of a safety-valve (the diameter of valve, length of lever and fulcrum being known) to withstand any given pressure of steam in a boiler; or who is not able to figure and determine the strain brought on the braces of a boiler with a given pressure of steam, the position and distance apart of braces being known; and no engineer or assistant engineer now holding a license shall have the grade of the same raised without possessing the above qualifications."

To Rule IX., Section 14, has been added as follows: "When it is known, or comes to the knowledge of the local inspectors, that any steam vessel is or has been carrying an excess of steam beyond that which is allowed by her certificate of inspection, it is recommended that the local inspectors in whose district said steamer is being navigated, in addition to reporting the fact to the U. S. District Attorney for prosecution under Section 4437, Revised Statutes, shall require the owner or owners of said steamer to place on the boiler of said steamer a lock-up safety-valve that will prevent the carrying of an excess of steam, and shall be under the control of said local inspectors.

"On the placing of a lock-up safety valve upon any boiler, it shall be the duty of the engineer in charge of same to blow or cause the said valve to blow off steam at least once in each watch of six hours, or less, to determine whether the valve is in working order, and it shall be his duty to report to the local inspectors any failure of such valve to operate.

"In case no such report is made, and a safety valve is found that has been tampered with, or out of order, the license of the engineer having such boiler in charge shall be revoked.

"It shall be the duty of the local inspectors to send a copy of this rule to every steamer in their district, when said copies are furnished by the department."

The rule in regard to wheel chains now reads as follows: "Masters and pilots of steamers on lakes and seaboard are required to have their wheel chains rove so that the wheel and helm shall move in the same direction, so that when the wheel is put to starboard the vessel's head shall go to port, and when the wheel is put to port the vessel's head shall go to starboard."

In regard to ascertaining the tensile strength of plates, the regulation now is that the test pieces from plates $\frac{5}{16}$ in. thick and less shall have an area of cross-section of $\frac{1}{4}$ sq. in.; for plates over $\frac{5}{16}$ in. and up to $\frac{3}{4}$ in. thick, the arc shall be equal in square inches to three-quarters the thickness of the plate in inches; for plates over $\frac{3}{4}$ in. thick the area shall be equal in square inches to one-half the thickness of the plate in inches.

The United States Weather Bureau.

(From *Science*.)

ALTHOUGH Congress has not ordered that the Weather-Bureau shall be transferred from the Signal Corps of the Army to some civil department, the steps that were taken towards the transfer give strong assurance that it will be made next year, when it can be undertaken more deliberately. The action was briefly as follows: the House bill No. 5190, to create a department of agriculture and labor, received several amendments in the Senate, among which the sixth had for its object the transfer of the weather-bureau from the Signal Office of the Army to the new department on July next. Although several senators voted on February 23 against this amendment, because they thought the action was too precipitate, it had a majority of 37 to 15, with 24 absent. It provided that the second lieutenants and the subordinate members of the corps should be transferred to the new department, without changing their work or their pay; that the rank of commissioned officers of the Signal Corps should not be affected by the transfer; and that the Chief Signal Officer should remain in charge of the bureau after the transfer until a director should be appointed for it. The bill then returned to the House, where, according to the reports we have received, it would have certainly been passed as amended, had not an unforeseen obstacle arisen. The President, it seems, does not desire an additional member in his cabinet; the bill was therefore referred back to the Committee on Agriculture by his friends in the House, and at this late date in the crowded session it could not again be reached, not being "privileged business." So the matter is dropped for the present.

This postponement is, on the whole, not to be regretted. It is quite clear that the failure to make the change was not due at all to a belief that it ought not to be made. Senator Edmunds offered the only considerable objection to the transfer during the debate on the amendment. It was clear to him "that the only way to have an effective organization is to have it under military control, so that a man cannot resign because he gets miffed about something, but he must do his duty." This mistaken impression found few if any supporters. It seemed to be generally understood that the loss of individuality and complete submission to authority, which constitute the essence of the military spirit, are out of place in a service that wisely makes open declaration of its need of intelligent personal action by calling on college graduates to enlist in it. Senator Dawes thought every one agreed that the service "ought to be transferred to the civil department of the Government," but believed that the transfer ought to be made more deliberately than was contemplated in the amendment. Senator Hale expressed the same views, and these two joined Edmunds and others in voting against the bill. But their favorable votes may be expected next winter, when perhaps less political and more appropriate surroundings may be chosen for the weather-bureau than it would have found in the proposed new department.

In the mean time the position of Chief Signal Officer is given to Captain Greely, who is thereby promoted to be a brigadier-general, the Senate having confirmed the President's nomination at the last moment. So great an advance in rank is unusual, and may be attributed in part to recognition of Arctic heroism,—for surely the preservation of a complete series of records under the most difficult and tragic circumstances was a splendid achievement,—and possibly in part to the feeling that the office should be given to some one already in the service, rather than to some colonel who stood, indeed, nearer in the line of promotion, but who had had no experience in the weather-bureau. But the failure of the deficiency bill makes the position of Chief Signal Officer an arduous one for the next year, for it is a thankless duty that involves reduction in some of the essentials of the service. It is to be regretted that the new Chief was not given at least the best opportunity of showing his powers. The remedy for unsatisfactory weather-predictions is not likely to be found while the service is thus embarrassed.

Limitations of the Expansion of Steam.

[From the *Journal* of the Franklin Institute.]

THE results of a mathematical investigation of the limitations of the expansion of steam, by Prof. William Dennis Marks, of the University of Pennsylvania, can be epitomized as follows:

We cannot expect, under the most favorable circumstances, to reach an economy which will surpass but very slightly one pound of coal per indicated horse-power per hour.

This would place 18 per cent. of the heat in coal as the extreme limit of its utilization. The condensation of steam occurs during its admission to the cylinder, and in some cases is surprisingly great.

The law of this condensation is as follows:

The condensation of the steam in the cylinder is proportional to—

1. The difference of temperatures of the steam at the point of cut-off, and while being exhausted.

2. To the area of cast-iron exposed to the entering steam up to the point of cut-off.

3. To the time of exposure of the interior surface of the steam cylinder to the exhaust steam.

4. The condensation is reduced by compression, subject to the same laws, but this is usually quite a small quantity.

The initial condensation of steam is due principally to the piston and cylinder heads.

The equilateral hyperbola approximates quite as closely as any other curve to the curve of expansion of steam in engines not embarrassed by a sluggish valve motion.

Compression will save some vaporous steam, but will not largely diminish the initial condensation because of its short duration.

Superheating is the most efficient expedient for economizing coal.

The steam jacket is not so efficient as is ordinarily assumed,

Slide valves are frequently the cause of large and unlocated losses.

The valves and pistons of steam engines are rarely steam-tight.

With properly designed compounded cylinders the ultimate expansion of the steam is a function of the ratio of the two cylinders.

The saving in compound engines is due to lesser initial condensation in the non-condensing cylinder.

From the physical properties of iron arises the necessity of, and advantage of, compound engines.

The beneficial effects of superheating, steam-jacketing and compounding, are more apparent in small than large engines.

The most economic ratio of stroke to diameter for steam cylinders is a function of the number of expansions, of the boiler pressure, of the exhaust pressure, and of the number of strokes per minute.

A large cylinder is more economical than an equal volume divided among small cylinders.

High rotative speeds demand shorter cylinders than are ordinarily used.

It is frequently, especially with high boiler pressure, the more economical to not use a condenser.

The throttling of steam, with an engine of fixed expansion and small cylinder, does not increase the consumption of coal per indicated horse-power per hour, but very slightly. W. D. M.

The Mining Industries of China.

THE United States Consul at Hong Kong, in a recent report on the mining industries of China, says:—"The small advances made by the Chinese in developing and utilizing the mineral wealth of their country, mainly attributable to the innate hostility of the people and the government to any innovation on ancient usages and customs, would appear to have received recently an impetus in the province of Kuantung, which justifies the expectation of impending progress. This is due mainly to the efforts and enterprise of Ho Amei, a native of Canton, who, after some years' residence in Australia, has returned to his native province, with the accumulated knowledge and experience derived from his connection with mining enterprises in that country. He has leased a silver mine at Tamchow, from which considerable ore had been taken, but the workings had been abandoned on account of water, which they could not get rid of with the appliances then used. To overcome the obstacle hitherto insuperable to mining as conducted by Chinese, he has provided mining machinery of the most modern and improved character. But his efforts to secure from the Chinese government the adoption of a more liberal policy in connection with mining operations are worthy of more attention. From a speech delivered by him at the opening of the Tai Yu Shan silver lead mine, a few miles from Hong Kong, we gather the following particulars, which are of importance in this connection. He has obtained from the provisional Government of Canton permission to work the mines. He endeavored to impress the Government with the important fact, that by opening up the mineral resources of the country, not only would profits accrue to those engaged in this business, but that great benefit would be derived from the employment of large numbers of the laboring classes, thereby furnishing remunerative employment to them at home, preventing emigration, and adding to the wealth of the country. He also urged the establishment by the Government of an office of mines, at which any person could obtain a license to open and work mines. This proposal has been favorably considered by the Viceroy, who has memorialized the Throne for imperial sanction, The Viceroy has already appointed two totais as superintendents of the mining office which was opened about March 1 last, and for about $1,025 any Chinaman could obtain a license to work any mine in perpetuity, the government receiving a royalty of the proceeds after all expenses are paid. This royalty the Viceroy and high officials have fixed at 10 per cent. for silver, that on other metals to be determined hereafter. More than 50 applications for licenses have been sent in since the office was opened, but before license is granted, the authorities will consult the residents in the vicinity of the proposed localities, to ascertain whether they object, for it seems admitted, that unless the operators have the support of the public, they cannot expect to succeed. I have deemed these facts of sufficient interest to report them, as they are indicative of progress, and justify the expectation that the day is not far distant when the mineral resources of this country will be developed, and a demand be created, not only for mining machinery of the most approved patterns, but also for the services of skilled mining engineers and other operatives, whose services must, for a time at least, prove indispensable. I will add that I have submitted this statement mainly because the Tai Yu Shan mine is located on the island of Lantao, only six or seven miles from Hong Kong, and that I had opportunity of judging by ocular inspection of the rich character of the galena exposed in the preliminary blastings."

The First Railroad in France.

(From the *Revue Scientifique*.)

MR. LEON AUCOC recalls the fact that in celebrating in 1887 the semi centennial of the inauguration of railroads in France a serious historical error will be committed.

In short he shows, from official documents, that the concession (or charter) for the railroad from St. Etienne to the Loire dates from February 26, 1823; that of the railroad from St. Etienne to Lyons from June 7, 1826; that of the railroad from Andrezieux to Rouen from August 27, 1828; and that of the railroad from Epinac to the Canal of Burgundy from April 27, 1830. All these concessions were made in perpetuity by royal ordinance. There followed the concession for the railroad from Alais to Beaucaire, the first case of a temporary or limited concession, which was authorized by the law of June 29, 1833. The railroad from Paris to St. Germain le Pecq was the sixth charter, by a law of July 9, 1835.

From the point of view of actual construction the line from St. Etienne to the Loire was opened October 1, 1828; that from St. Etienne to Lyons, in part, October 1, 1830; from St. Etienne to Roanne, February 5, 1834, while the road from Paris to St. Germain was only opened August 26, 1837.

The first railroads, it is true, were exclusively intended for the transportation of freight, and the motive power was furnished by horses or by stationary engines. But the transportation of passengers on the St. Etienne-Lyons line was begun in July, 1832, and in 1836 the number of passengers carried over the road exceeded 170,000. Finally it was at the same date, July, 1832, that Marc Seguin, who had taken out, in February, 1828, a patent for a tubular boiler, used for the first time on the St. Etienne-Lyons lines, the motive power which completes the railroad and gives it its true character, the locomotive.

In short, to pretend to celebrate in 1887 the semi-centennial of French railroads, according to this writer, is not only to mis-represent or to be ignorant of history; it is to lower the flag of France before several other nations, when in fact she either surpassed or at least equalled them in the beginning of her railroad system.

Manufactures.

Special Tools for Railroad Repair Shops.

In June, 1884, the Committee on Shop Tools and Machinery said, in its report to the Master Mechanics' Association:

"The age of special tools and machinery has come to stay, and those who adhere to old-time notions of doing work, getting one machine to do many kinds of work, doing no kind economically or accurately, will certainly be left behind."

This statement was doubtless correct and to the point.

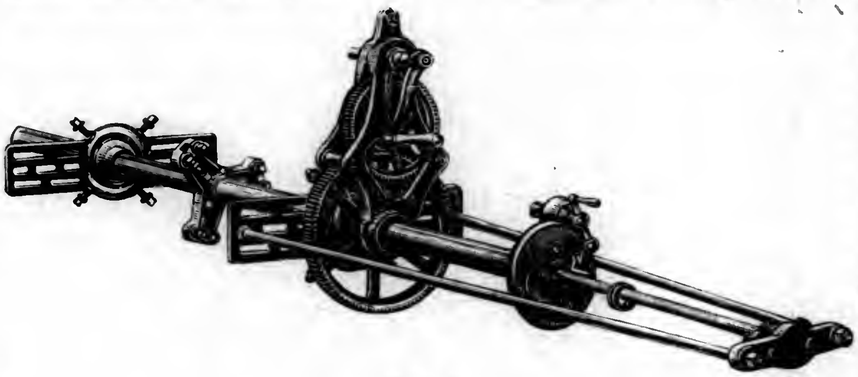


Fig. 1

The consolidation of railroads makes duplication of parts necessary for proper and efficient maintenance of repairs to locomotives and rolling stock generally; this duplication of wearing parts makes special tools and machinery a necessity, and new devices are being continually placed on the market. All machine-tool builders have their specialties and aim at the production of tools, the use of which will cheapen and simplify the work for which it is designed. Portable tools and machinery which are light and easily handled, have proved invaluable for round-house and repair-shop work; these machines can be taken to the work, and only those parts requiring repairs need be removed. This facilitates the work very much, and at the same time gives the use of the expensive stationary machine hitherto used, for other kinds of work.

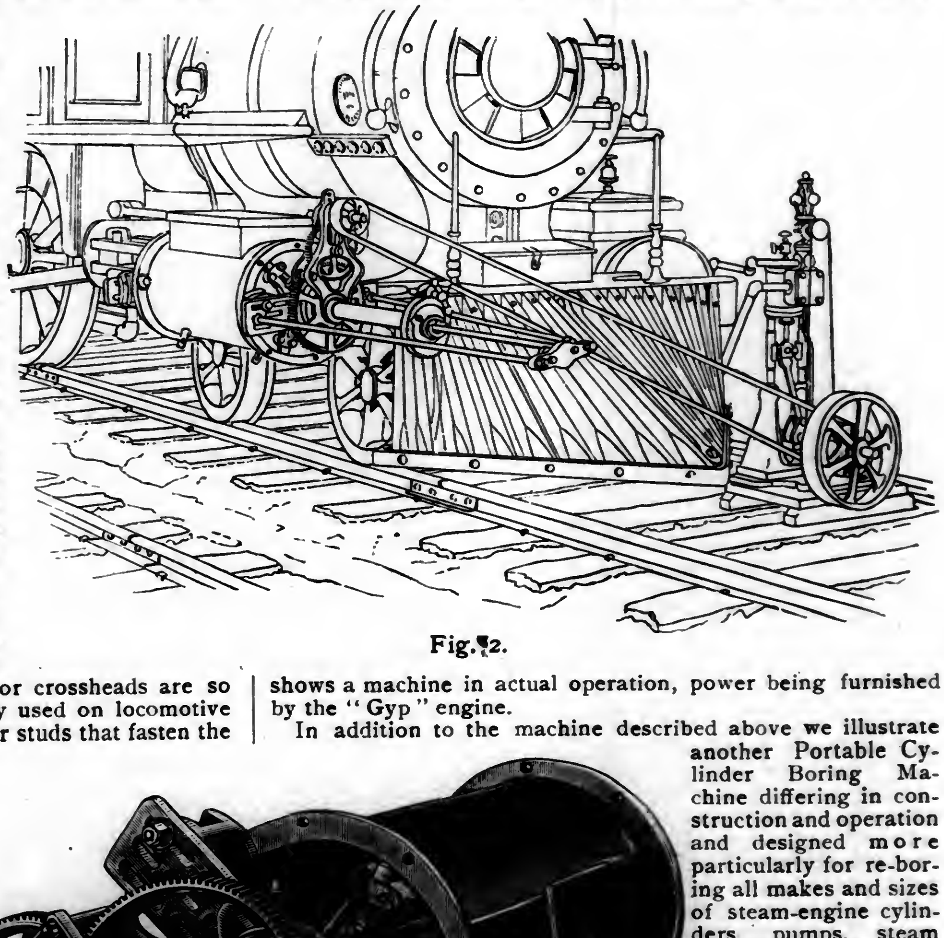


Fig. 2.

The first machine described in this article, and one of the earliest machines introduced in this particular line, is a Patent Portable Locomotive Cylinder Boring Machine, designed and used for boring out locomotive cylinders in their places by the removal of one or both heads and piston; the back-head, crosshead and guides need not be removed unless so desired. On removing the piston and leaving the front-head and stuffing-box, a small cone takes the place of the stuffing-box at once, and with proper adjustment at the front-head the machine is ready for work. It is fed with a constant feed of cut gears. The clamps or crossheads are so arranged that they may be conveniently used on locomotive cylinders of all sizes. The same bolts or studs that fasten the cylinder head on are used to bolt the bar-supports also. Two rods are fastened to the ends of the cross-head that supports the bar in the cylinder and to an adjustable swivel crosshead on the end of screw; these take the whole of the thrust and torsion strain of the bar. It makes no difference what position the bar is in, the end thrust is always in exact line with it, causing it to cut steady, smooth and absolutely true. The feed-nut is in halves, held together by a round nut, so that when the cut is through he cylinder, by unscrewing the round nut, opening the half-nuts, loosening the tools so that they will not mark the cylinder in moving back and pushing in the end of bar until the cutter-head is in its place, it is ready for work. The feed can be thrown out of gear at any time by simply screwing up the round-milled nut, and by loosening the nut the machine will feed automatically. The larger sizes of this machine are made with convenient change of feed so that after the roughing or truing cut has been taken, it can be instantly changed to a coarse feed, finishing quickly and accurately. An attachment is made with the driving power for holding it in position, rigid and firm, one end being fastened at the extreme end of the driving power, the other at the crosshead. By placing the crosshead vertically the driving power can stand horizontally, the bar is accurately ground, bearings scraped out to fit and it will stand a great amount of wear before loss of motion occurs. Cutter-heads are furnished for boring driving-boxes. These machines are built any size required and can be run by hand or power as desired. Fig. 1, shows machine with crank for turning by hand; fig. 2, shows a machine in actual operation, power being furnished by the "Gyp" engine.

In addition to the machine described above we illustrate another Portable Cylinder Boring Machine differing in construction and operation and designed more particularly for re-boring all makes and sizes of steam-engine cylinders, pumps, steam hammers, blowing engines, air compressors, mining and hoisting engines, Corliss valves, hydraulic and steam-hoists, heavy housings, large wheels, etc., etc. In this machine the boring head travels, while in the former one, the bar travels. It is only necessary to take off the cylinder-head and remove the piston, when the cylinder can be rapidly and accurately bored out. This saves breaking the steam joints,

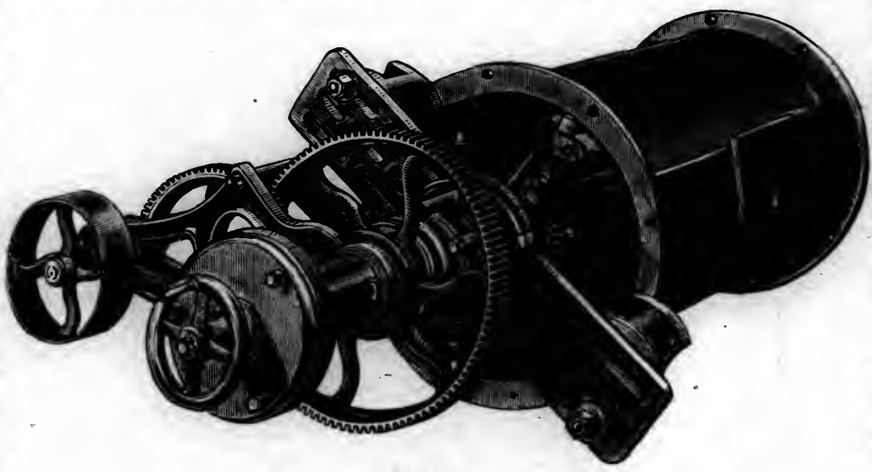


Fig. 3.

bolts, etc., and often the cylinder can be re-bored in less time than it would take to remove a cylinder from its bed. The cutter-heads are fed by a screw in one side of bar and operated by the feed-casing on the end which contains the gearing, by changing position of which two changes can be made and slow feed for roughing out and a fast for finishing cuts. The feed is automatic and at the pleasure of the operator. The bar is driven by a train of powerful cut gears, either with a crank or belt for power. With this machine there is furnished a self-centering chuck which fits in the stuffing-box, supporting the bar in a central position at the end. Fig. 3 gives a general view of this machine, while fig. 4 shows same re-boring in its present position on the engine-bed the cylinder of a mining engine.

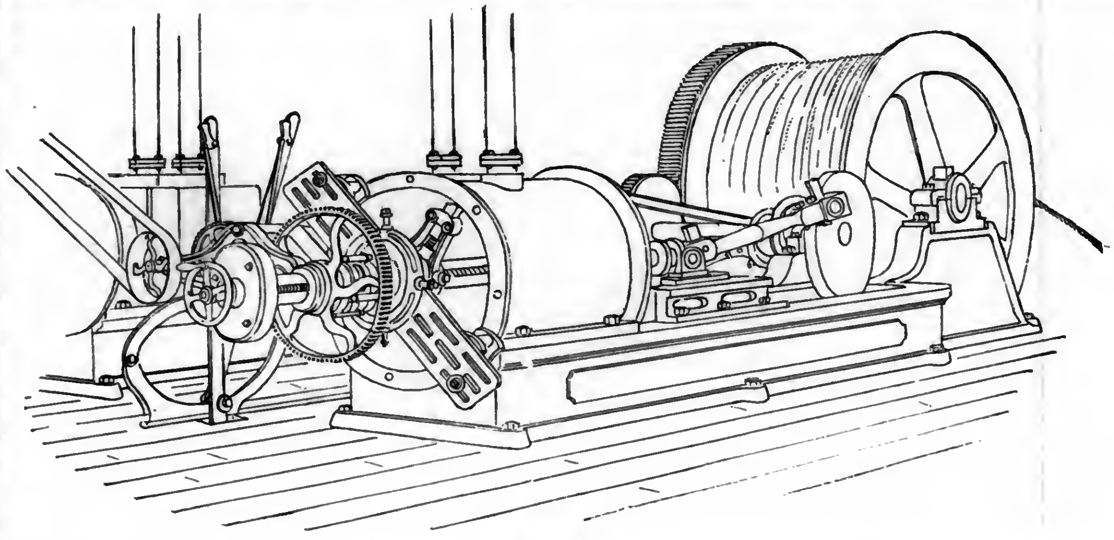


Fig. 4.

The employment of expert men for the facing of a valve-seat by hand is absolutely necessary, and as is well known it is a long and expensive job. A machine that will do this work rapidly and at the same time accurately, if not too expensive, is a great saving in time, labor and material. The Patent Portable Valve-Seat Rotary Planing Machine described below has been in successful use for years, even smaller lines of railroad with few locomotives finding it an economical tool. It has been used very extensively by its manufacturers in facing off the valve-seats of stationary engines, and they recently trued up the valve-seat on an upright plowing engine in Western Virginia, sending a man with machine to do the work. It has also been adapted with slight changes to various other uses, one of which is the manufacture of large stops for water mains. The Philadelphia Water Department has a 48-in. machine (fig. 5), the largest ever built, in almost constant use. This machine can face off a 48-in. stop, insert the brass rings and finish up in 10 hours, and when the machine is not in use, it is swung out of the way and the room utilized for other work. The construction, mode of attachment and operation of the machine, for general purposes (fig. 6.), is easily understood after an examination of the cut. There are two horizontal disks, the upper secured by radial arms, adjusted to suit the position of the studs in the valve-seat; the lower, carrying the cutter and its slide, revolves freely against the upper, and is held in place by a king-bolt passing through its center. This lower plate is also secured by a circular gib upon its circumference, which admits of taking up the wear. It is an annular gear, having teeth cut on its inner periphery, from which it receives its rotary motion by means of its connections with the bevel gears and crank. The crank may be replaced by a pulley if power be convenient. The double-bevel shaft acts like a back gear and admits of a change of speed. Either bevel is thrown into gear at pleasure by the movement of a pin in a slot operated by the hand-wheel. If the outer bevel is in action, it gears directly into the lower plate; if the inner bevel, it is slow geared to the outer, and that to the plate. The revolving lower plate is fitted with the V slide and the tool-post, and is fed by a screw and star wheel, arranged to give a large variation in the feed, from roughing to finishing, etc. The cutter is conveniently fed down by the operation of a nut on the cutter-spindle acting against the tool-post. The radial arms which secure this machine to the studs are so finished with slots as to give a wide range of adjustment.

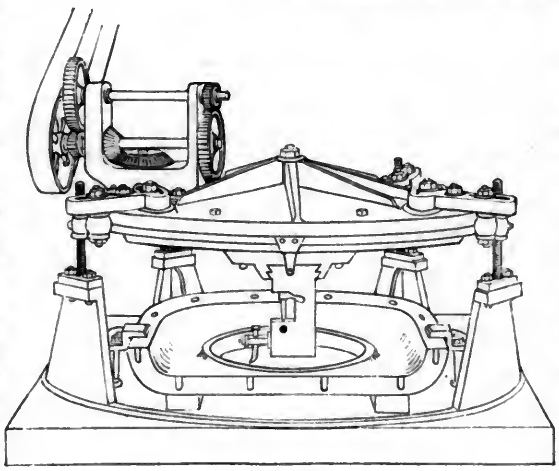


Fig. 5.

Great care has been taken to have the nuts and washers, that are furnished on the studs for holding the machine, clamp the radial arms so as not to spring the machines. The nuts are turned convex, and the washers are bored out concave, so that a perfect ball-and-socket joint is formed, allowing adjustment of the machine and holding it firm and solid, even though the stud should be out of line. In case the stud holes in a small seat should come inside the plates, four other radial arms are furnished with the machine, fitted with a T-slot, and with a hole at the other end corresponding to the hole for the old stud, thus affording facilities for extreme cases.

This machine, it is claimed, will do the work accurately, without the use of files or scrapers after the machine has faced off the seat. The plates are set true

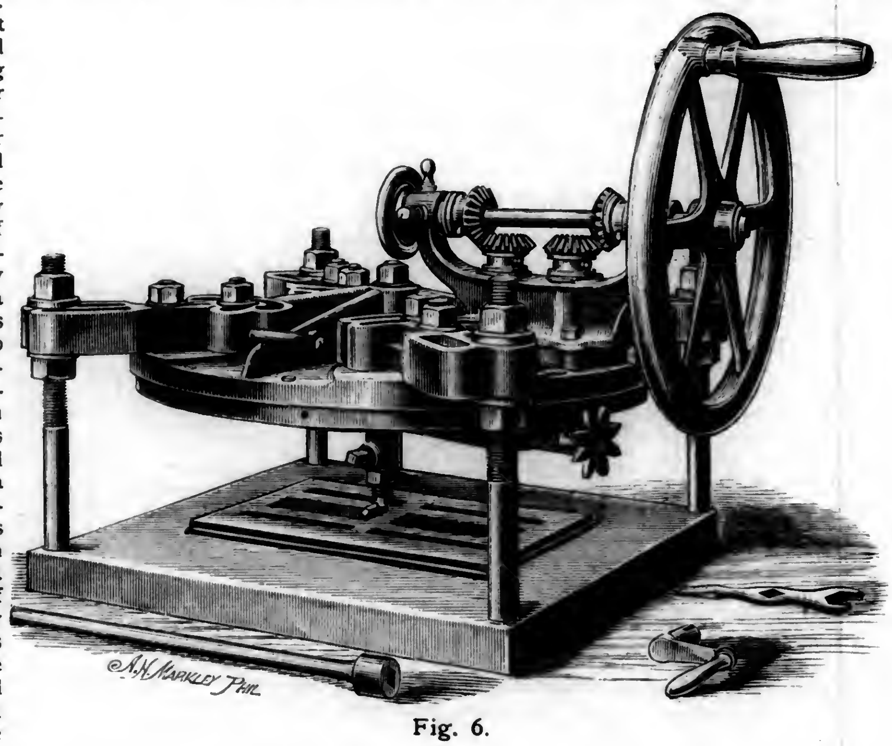


Fig. 6.

with the unworn parts of the valve-seat, consequently the new face will be likewise true. It is readily seen that the work done is exactly in line with the travel of the valve-stem, thereby preventing the yoke from slipping up and down the valve, as well as all extra friction on the valve-stem. No more material need be removed than is absolutely necessary to true up, thus saving the seat. The work is done by a con-

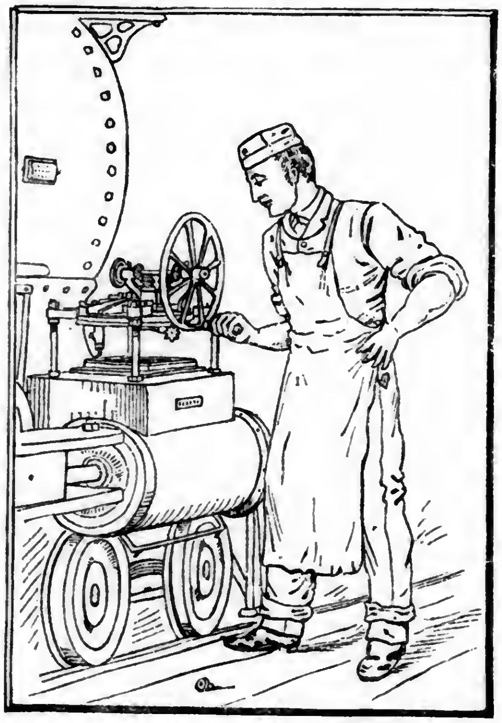


Fig. 7.

tinuous cut, and the loss of time from the return motion of the ordinary planer avoided. There is also no breaking out of the edges. It is estimated that an ordinary locomotive valve-seat can be trued up in two hours. These machines are strong and well fitted up, are easily handled and ought to be an excellent tool in every respect. They are built in three sizes, 18, 22 and 26 in. The 22-in. style is sufficient for all but the very largest class of locomotives. All the wearing surfaces are carefully scraped by hand, and the machines are thoroughly tested before being shipped from the works.

Fig. 7 shows this machine in operation by hand.

The Patent Portable Valve Chuck is used only in combination with the portable valve-seat rotary planing machine and is built in three sizes to suit the same. For round-house and repair-shop work, it is valuable, as the use of the planer is obviated entirely. The lower plate has dove-tailed slides that carry two movable jaws, operated by a right and left-hand screw, bringing them up central, firmly clamping the back of the valve and holding it central for planing. The four uprights at the corners have about 2 in. of adjustment, with graduations, enabling the machine to be set parallel with the table. After the seat has been faced, the machine is taken off and placed on the four graduated uprights of the chuck, the workmen then proceeding to face the valve. Fig. 8 shows the machine proper, and fig. 9 shows the machines in combination.

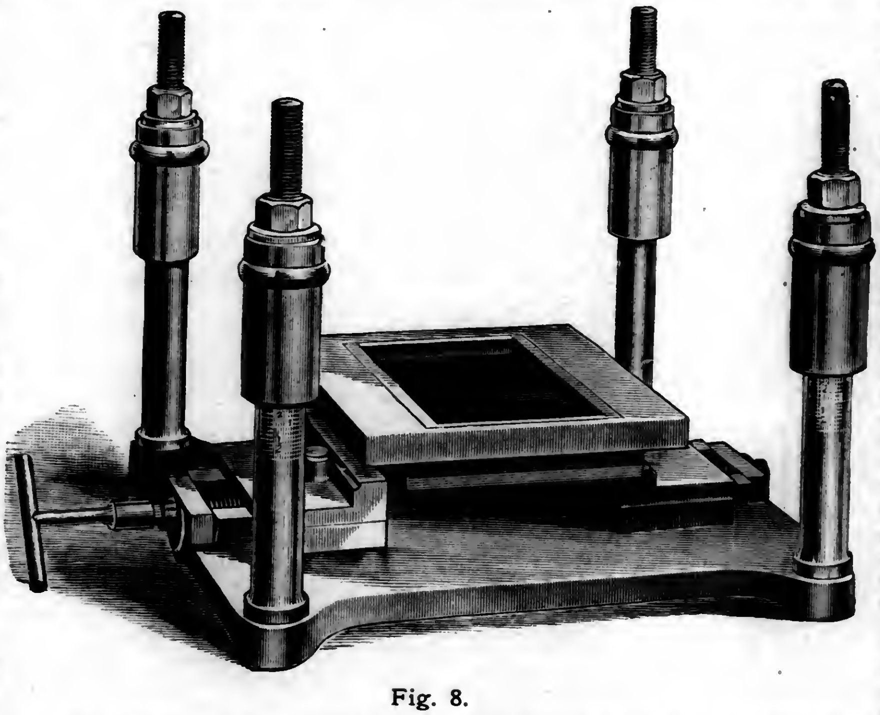


Fig. 8.

The tools illustrated in this article are made at the L. B. Flanders Machine Works of Messrs. Pedrick & Ayer in Philadelphia.

Vulcabeston.

The H. W. Johns Manufacturing Company, of New York, has brought out this new material, composed of asbestos combined with water and acid-proof materials, vulcanized and compressed. It is used for piston, piston-rod, ring-flange and

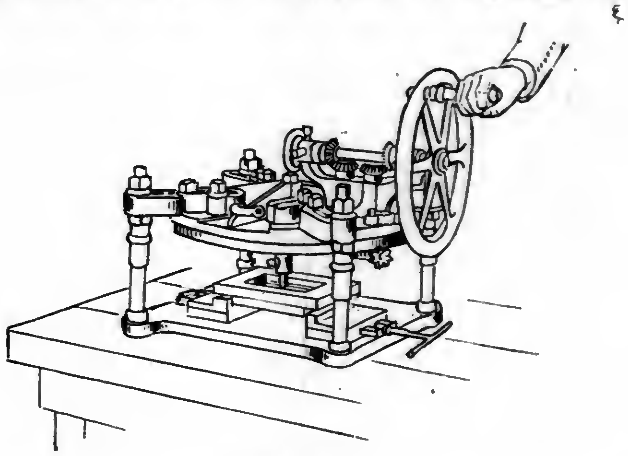


Fig. 9.

sheet packing, gaskets, washers, etc. One kind of vulcabeston is made water-proof and another kind fire and water-proof. The first is used for acid chambers for electric batteries, and the second is a non-conductor of electricity, but is not acid-proof.

Pumping Engines for the Potomac Flats.

At the last meeting of the Engineers' Club of Philadelphia, Mr. A. P. Broomell presented a description of the large engines which are to drive the centrifugal pumps in the works for draining the Potomac Flats at Washington. This description is given in the proceedings of the Club as follows:

"These engines have 24 X 24-in. cylinder. They are exceptionally heavy and substantial, the bed-frames alone weighing close to five tons. They will have automatic cut-offs, using my patent valves and governor. So far as I am aware, this is the first instance of using automatic cut-off governors of the single-valve type on connected engines. Since the shafts, and runners of pumps wear out very rapidly, it is necessary to make all parts of the governor in halves so that they may be readily taken off for renewal of shafts. The requirements of this work are very severe on engine, the speed being 160 revolutions as a regular thing, and at times as much as 200 revolutions per minute. To prevent the engine working endwise at this high speed, it being attached only to the floor of dredgers, is a pretty difficult matter. The plan I have adopted is a caging of heavy steel I-beams, firmly bolted and riveted together.

We are making two pairs of these engines, as well as five smaller ones for these parties. A few of the leading sizes are:
"Crank-shaft of hammered steel, 13 ft. long, 11 in. diameter. Main-bearings, 17 in. long, babbitt lined. Crank-pins, 6 × 6 in., hammered steel. Piston rods, cast-steel, 3⅜ in. diametet. Piston-heads have self-packing rings of cast-iron. Steam-pipes, 6 in. diameter. These dredging machines are owned and operated by Messrs. Benson & McNee, of Washington."

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 88.)

CHAPTER V.

SMOKE BOXES.

As early as 1859 some engines were built, at the Rogers Works for the New Jersey Railroad & Transportation Company, with a form of extended smoke-box, shown in figs. 93

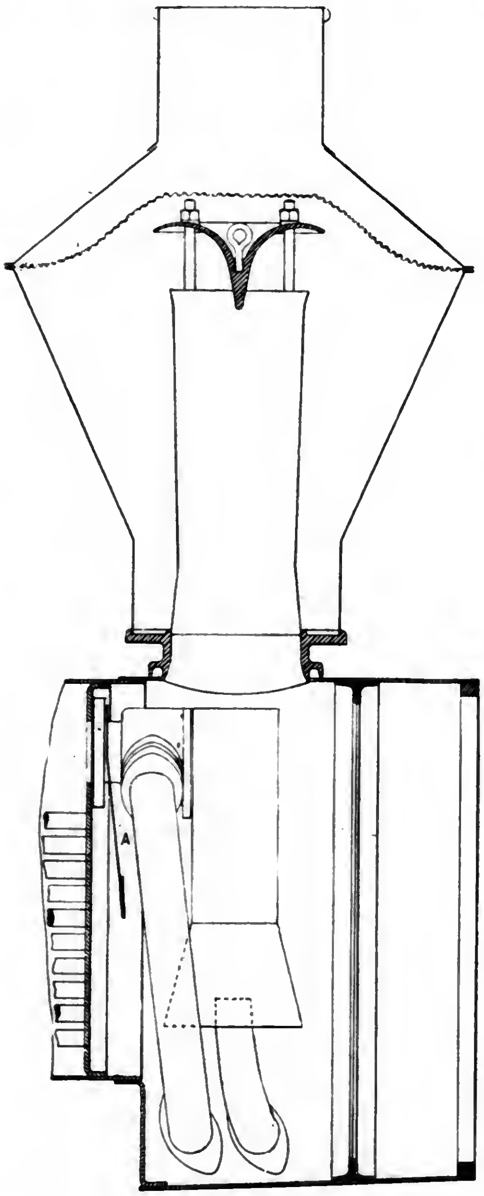


Fig. 93.

and 94. A deflecting plate, *A*, was used in front of the top rows of tubes. In the same year the form of plate shown in figs. 95 and 96, which had an adjustable piece, *B*, on its lower edge, was used on engines, both with and without the extended smoke-box. In 1862, the telescopic or adjustable petticoat pipe, shown in fig. 97, was applied to engines for the Nashville & Chattanooga Railroad. Figs. 98 and 99 show the extended smoke-box as recently applied to passenger engines. *A B* is a deflecting plate in front of the tubes, and *C C C* is wire netting of number 13 wire, and 2½ meshes to an inch. The exhaust nozzles *F F*, it will be seen, are carried up above the horizontal center-line of the boiler. A receptacle, *D*, for sparks, is attached to the under side of the smoke-box, and has a sliding door, *E*, for emptying the sparks and cinders which accumulate in the front end.

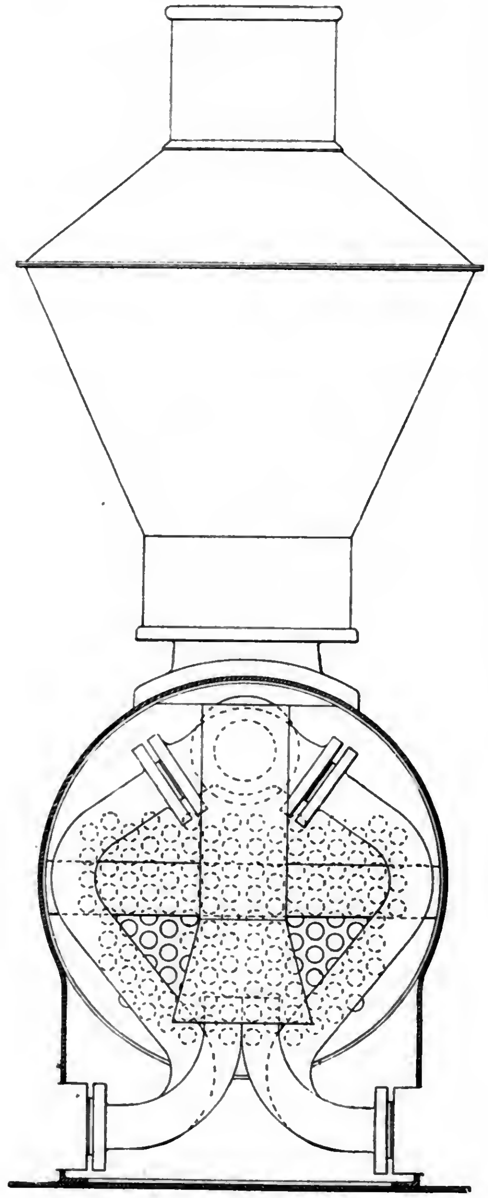


Fig. 94.

The extended smoke-box, when it was first introduced, met with little favor, but in recent years it has been extensively used.

FEED-WATER HEATER.

In 1859, Mr. Hudson designed a feed-water heater, which is represented by fig. 100, which he applied to a number of engines for the Southern Railroad of Chili, S. A. It consisted of a cylinder, *C*, filled with small tubes *F*. At the end of the cylinder there was a chamber *A*, and another, *B*, at the opposite end, which was connected together by the small tubes. The exhaust steam were admitted to *A* from the exhaust pipes by a pipe *D*, and passed through the small tubes to *B*. The condensed water ran out through the pipe *L*, or it was conveyed to the ash pan. If not condensed, the steam passed through the pipe *G* to the chimney. The water from the pump entered the heater at *E*, and escaped by the pipe *F*, to the check valve. This heater was used for some time, but, as has occurred in numberless experiments with feed-water heaters, it was finally abandoned under the impression that its cost was greater than the saving it effected.

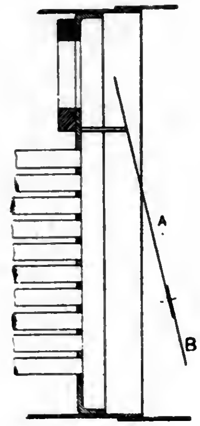


Fig. 95.

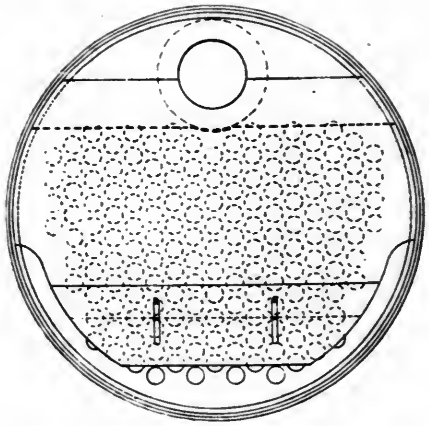


Fig. 96.

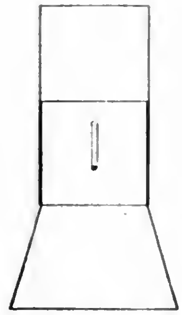


Fig. 97.

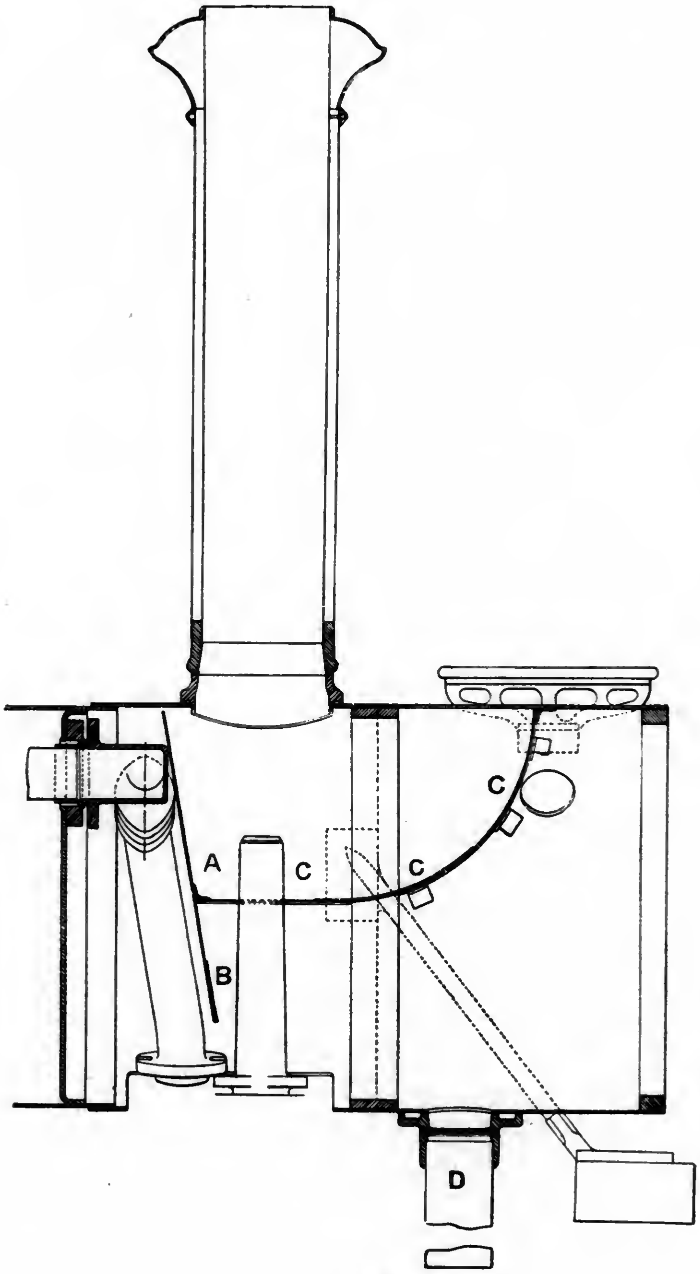


Fig. 98.

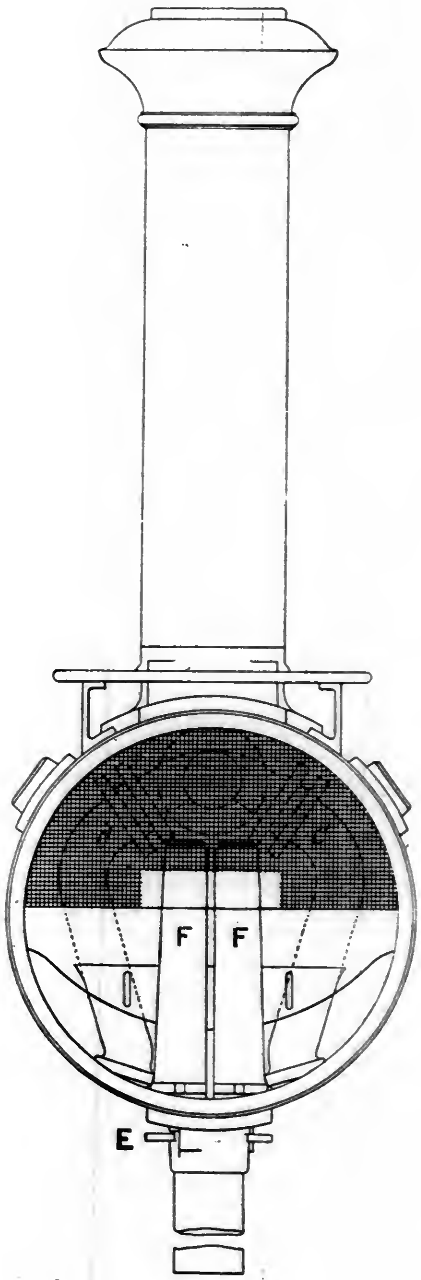


Fig. 99.

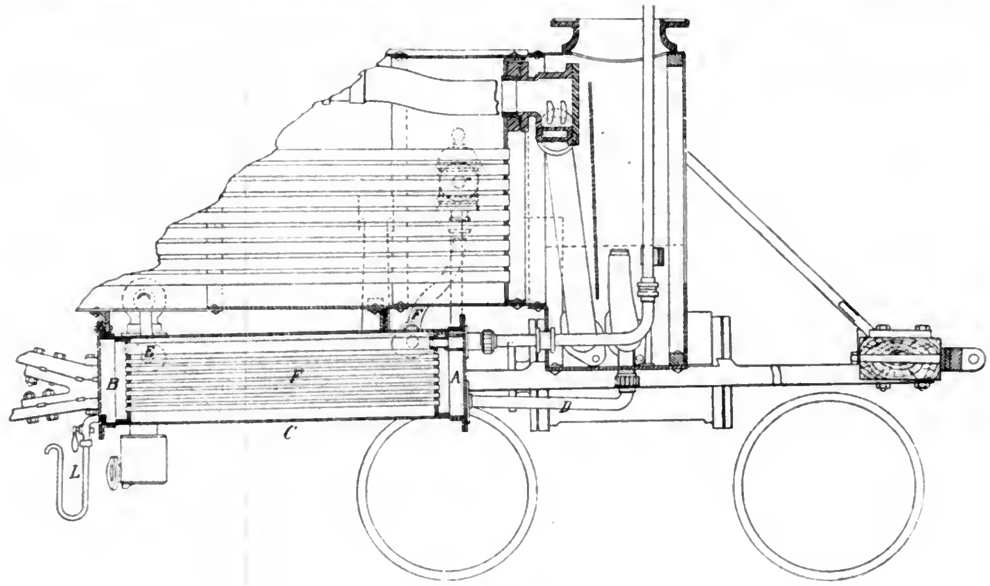


Fig. 100.

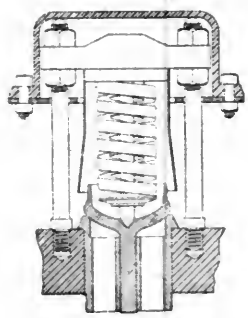


Fig. 104.—1872.

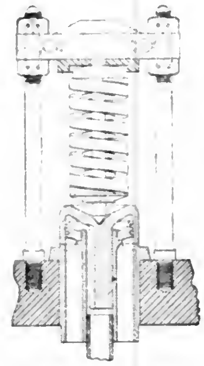


Fig. 105.—1875.

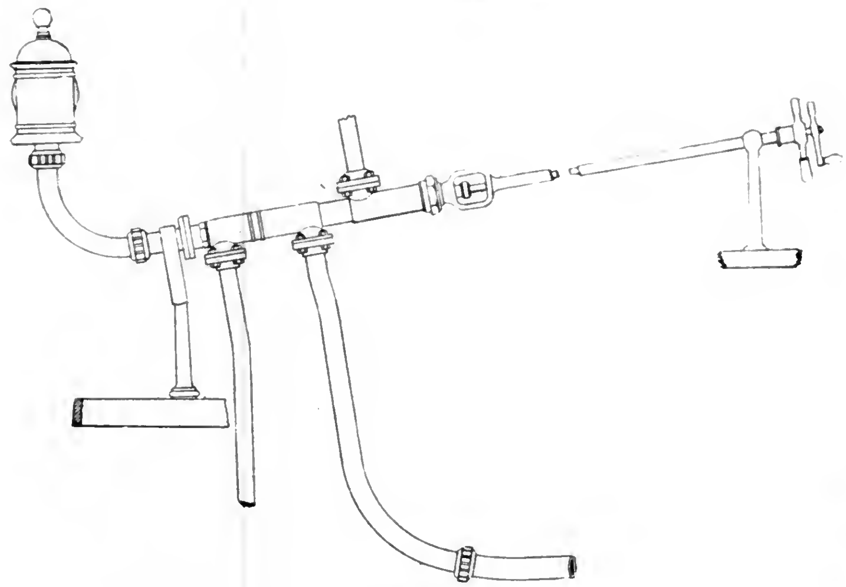


Fig. 101.

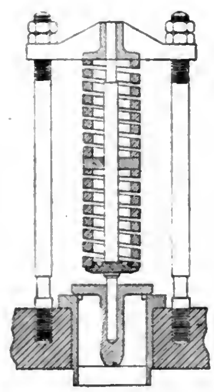


Fig. 106.—1882.

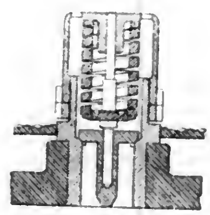


Fig. 107.
Steam Chest Safety Valve,—1882.

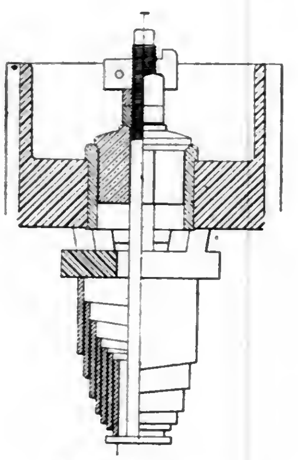


Fig. 102.—1869.

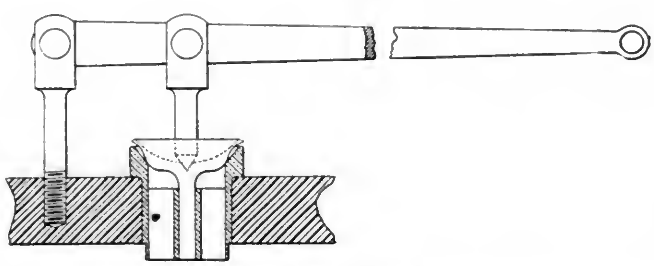


Fig. 103.—1872.

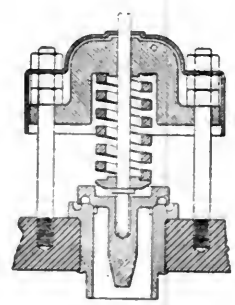


Fig. 108. —1883

INJECTORS.

Injectors were first applied to locomotives at the Rogers Works in 1861. Fig. 101 shows the arrangement then used. Since that time they have been much improved and are almost universally used for feeding locomotive boilers.

SAFETY-VALVES.

Figs. 102 to 108 represent different kinds of safety valves which have been used at various times, the construction of which is made sufficiently clear by the engravings, without other explanation. The dates when they were first used is given below each figure.

(*To be continued.*)

Belgian Locomotives For Panama.—The Panama Railroad Company has ordered 30 locomotives in Belgium, 18 from the St. Leonard Company and 12 from the John Cockerill Company at Seraing.

Proceedings of Societies.

Master Car-Builders' Association.

THE office of M. N. Forney, Secretary of the Master Car-Builders' Association, will, on May 1 next, be removed from No. 23 Murray street to No. 45 Broadway, New York. All business letters and communications intended for the Secretary should be addressed to him at 45 Broadway from May 1, accordingly.

Engineers' Club of Cleveland.

THE annual meeting of this Club was held in Cleveland, O., March 8. Reports were received from the officers and committees, and the following officers were elected for the ensuing year: President, John Whitelaw; Vice-President, W. R. Warner; Corresponding Secretary, C. O. Arey; Recording Secretary, C. M. Barber; Treasurer, S. J. Baker; Member of the Board of Managers of the Association of Engineering Societies, M. E. Rawson.

The Committee on National Public Works reported that a meeting of civil engineers would be called during the summer at Washington, to take measures to influence legislatio in the next Congress.

Boston Society of Civil Engineers.

THE annual meeting was held in Boston, March 16. President George L. Vose in the chair. The officers and Governing Committee presented their annual reports.

After the reading of the reports, officers for the ensuing year were elected as follows: President, L. F. Rice; Vice-President, F. P. Stearns; Secretary, H. L. Eaton; Treasurer, Henry Manley; Auditor, Thomas Aspinwall; Librarian, H. D. Woods.

After the adjournment of the business meeting, the annual dinner of the Society was given at Young's Hotel, a large number of members and invited guests being present.

Canadian Society of Civil Engineers.

THE organization of this Society was completed at a meeting held in Montreal, Feb. 24. The same evening the members attended a reception given in honor of the new society.

T e officers chosen are: President, T. C. Keefer; First Vice-President, Walter Shanley; Second Vice-President, Col. C. S. Gzowski; Third Vice-President, J. Kennedy; Secretary and Treasurer, Prof. Henry J. Bovey; Council, Alan Macdougall, H. F. Perley, F. N. Gisborne, H. D. Lumsden, H. S. Poole, P. W. St. George, E. P. Hannaford, H. Wallis, S. Keefer, Hurd Peters, H. N. Ruttan, W. T. Jennings, H. T. Bovey, Louis Lesage, P. A. Peterson.

The headquarters and place of meeting of the new society will be in Montreal.

New England Water Works Association.

THE regular monthly meeting was held at Young's Hotel, Boston, March 9, about 50 persons being present.

Mr. Albert F. Noyes, City Engineer of Newton, Mass., read a paper on Driven Wells as a Source of Water Supply. He began with a historical sketch in which he named when, where and by whom the use of driven wells was begun in this country. Colonel Green and Calvin Horton are closely identified with this method of obtaining water. The paper described in considerable detail the tools and methods employed, and distinguished between driving and boring.

The great difference in the quantity of water which is stored in the voids of different soils was noted and figures were quoted. The writer insisted that the amount of water to be obtained from any system of pipe-wells can only be known with any approach to certainty after thorough experiments extending over a considerable period of time. The question as to the comparative amounts of water to be obtained from driven and open wells was briefly discussed and the conclusion reached that no general rule could be formulated. By the courtesy of Chief Engineer Van Buren, Mr. Noyes was able to give full details of the Andrews driven wells in use at Brooklyn, N. Y., which may be quoted as a successful example of this method of obtaining water. Cohassett, Hyde Park and Westboro, Mass., were mentioned as towns in which driven wells have been successfully used.

The paper was discussed at length by Messrs. M. M. Field, J. A. Tilden, C. F. Allen and President Rogers. Opinions were expressed that where driven wells were used it was necessary to have careful inspection to determine the quality of the water before using it; also, that no more water can be obtained by any patented process than can be had by any simple method of driving.

Engineers' Society of Western Pennsylvania

A REGULAR meeting of this Society was held in Pittsburgh, March 15. Resolutions of regret at the death of Captain James B. Eads were unanimously adopted.

Mr. Thatcher read a paper on Bridge Specifications, with especial reference to those adopted by the Keystone Bridge Company. This paper called out a long discussion.

Colonel J. P. Roberts then read a paper on the High and Low Water Lines as fixed at Pittsburgh, pointing out the difficulty of determining either. He proposed the adoption of a system for the determination of these lines up the Monongahela to McKeesport, up the Allegheny to Hulton and down the Ohio to Sewickley. It was decided to appoint a committee of seven to lay the matter before Col. W. E. Merrill, of the United States Engineers, the city authorities, the Chamber of Commerce and the Coal Exchange, to report back any modifications or improvements which it may deem advisable.

The Society has secured permanent quarters in the Penn Building in Pittsburgh, and its meetings will be held there hereafter.

American Society of Civil Engineers.

AT the meeting of March 2 Mr. Wm. Metcalf read a paper on Steel: Its Properties; its Use in Structures and in Heavy Guns. An abstract of this paper will be found on another page.

This paper was discussed by Major Miller, Captain F. V. Green, Commander Robson, Lieutenants Danenhower and Rogers, Mr. R. W. Hunt and others. Letters were also read from Senator Miller and Lieutenant Ingersoll. Owing to the length of the paper and the lateness of the hour, the discussion was necessarily brief, and it was decided to take up the subject again at the regular meeting in April.

At the meeting of March 16 a paper was read by Mr. C. W. Tompkins, on the Brick Industry in New York and its Vicinity. This paper gave an interesting account of the manufacture of bricks at various points near New York. It was followed by a short discussion.

Mr. A. M. Wellington then gave a short account of the Bussey bridge on the Boston & Providence Railroad, the fall of which caused the recent very fatal accident.

Mr. Henry S. Pritchard, of Philadelphia, was introduced by Mr. Wellington and gave an account of his investigation of the fallen bridge. He also showed two broken eye-bars taken from the bridge.

Engineers' Club of St. Louis.

A REGULAR meeting was held in St. Louis, March 2, President Potter in the chair; 24 members and 3 visitors present.

Messrs. Alexander E. Abend, Charles F. Muller, Max G. Schinke and Lewis Stockett were elected members.

Mr. Robert Moore then read a paper on the Present Aspects of the Problem of Inter-Oceanic Ship Transfer. A history of the various schemes which had been made public was given, as well as the results reached and the difficulties yet to be met. At present the question had narrowed down to three prominent routes, each of which had its supporters. The De Lesseps Panama Canal was discussed at length, the present condition of the work noted, its cost thus far, and the amount necessary to finish it shown. This, as well as the grave engineering difficulties to be solved, and on which the success of the work hinged, led the speaker to believe its completion impossible and its early collapse probable. The second scheme, known as the Tehuantepec route was, for topographical reasons, not available for a canal, but has been chosen by Capt. Jas. B. Eads for his ship railroad. This plan was also discussed at length, and its advantages and disadvantages considered. The great first cost, the cost of operating, and the serious and as yet unsolved engineering difficulties to be met, seemed to throw the preponderance of evidence against the enterprise. The third scheme was that known as the Lake Nicaragua Canal which, so far, has not been as prominently mentioned as the others. While its first cost is un-

doubtedly great, it is not so large as either of the others, and its operating expenses would be much less. The work was of great magnitude, but yet of a character which had already rn many instances been successfully handled, and in the whole toute nothing new or untried would be met. On the whole, he speaker believed the Nicaraguan scheme the one which best deserved the recognition and support of the American people.

The paper was discussed by Messrs. Potter, Seddon, McMath, H. C. Moore and Ockerson.

A REGULAR meeting was held in St. Louis, March 16; 26 members and 2 visitors present. Mr. George W. Dudley was elected a member.

The President made the formal announcement of the death of Capt. Jas. B. Eads, suggesting appropriate action by the Club.

On motion the President was directed to appoint a committee of three to draw up suitable resolutions. Messrs. McMath, Moore and Holman were appointed such committee. On vote it was decided that the Club attend the funeral in a body.

The President announced the receipt from the Mississippi River Commission of a map of the alluvial basin of the Mississippi River from the St. Francis basin, south.

Mr. Carl Gayler then read a paper on Anchorage of Suspension Bridges, describing the common practice, and making some criticisms; also suggesting certain improvements, as adopted in the city's practice. The paper was discussed by Messrs. Johnson, Frith, Holden, Seldon, Macklind and Moore.

The Club then adjourned.

American Society of Mechanical Engineers.

THE following circular has been issued by the Secretary, Mr. F. R. Hutton:

"By a resolution of the council, pursuant to the request and suggestion of a large number of the members, the XVth Meeting of the Society will be held in the City of Washington, D. C., about the middle of May, 1887. The exact date and further details will be the subject of later announcements.

"Papers for this Meeting must be in the Secretary's hands before March 25, and titles should be sent on at once. It may be mentioned that fewer papers than usual have been so far contributed and promised, and the obligation is urged upon every member to see that our *Transactions* are not allowed to deteriorate in value from his inaction. Topics are also solicited for the topical discussions at once. The Secretary will be glad to correspond immediately with members who have subjects to present."

Master Mechanics' Association.

MR. J. H. SETCHEL, Secretary, has issued the following circulars from his office at Dunkirk, N. Y.:

PROPORTIONS OF LOCOMOTIVE CYLINDERS.

1. What rule do you recommend being used in calculating proper size of cylinders of passenger locomotives, when boiler steam-pressure, diameter of driving-wheels and weight on same are given quantities?

2. State what, if any, deviation from this rule should be made in the case of freight and switching engines.

3. State your reasons for adopting such rules, and, if possible, demonstrate the correctness of the same by results obtained in every-day practice.

4. In making the calculations referred to, do you assume the diameter of driving-wheels to be diameter outside the tires when new, or when half worn? What percentage of boiler pressure do you assume to be the average cylinder pressure?

5. Does your experience indicate that engines in which the ratio of weight on drivers to tractive power is much below the average, give better or worse results in work done, and in the economical performance of same, than engines of same tractive power, and in which the ratio between weight on drivers and tractive power is above the average? Is life of tires longer in one case than the other?

6. If you can present any facts bearing on this subject and which may be of service to the Association, you are respectfully requested to communicate the same.

F. L. WANKLYN,
T. E. BARNETT,
CHARLES BLACKWELL,
Committee.

Replies should be addressed to Mr. Charles Blackwell, care Union Pacific Railway, Omaha, Nebraska.

ARRANGEMENTS FOR ANNUAL MEETING.

Arrangements have been made with the proprietors of the Hotel Ryan, St. Paul, for the accommodation of members of the Association and their friends who will attend the 20th annual convention, to be held at St. Paul, commencing Tuesday, June 21, 1887.

The charge will be $2.50 per day for each person. Additional charges for extra accommodations.

Members requiring rooms are requested to engage them if possible before June 1, by filling up the enclosed blank and mailing it to the Hotel Ryan, St. Paul, Minn. Any members who, after having secured rooms as above, find themselves unable to attend, will confer a favor by notifying the proprietors of the Hotel Ryan at as early a date as possible.

G. W. CUSHING,
CLEM HACKNEY,
R. W. BUSHNELL,
Committee.

Engineers' Club of Minneapolis.

AT the last meeting of this Club in Minneapolis, Feb. 21, a letter from G. W. Wilder, of New York, on Coast Defenses, was read:

The subject of Heating Railroad Cars by Steam was discussed, the universal opinion being that it was time to take some action relative to heating cars that would insure safety as well as comfort.

The Club appointed the following standing committees for the ensuing year:

Library and Literature—W. W. Redfield.

Bridges and Material—F. W. Coppdin, A. J. Riggs and William R. Hoag.

Railroads and Transportation—J. W. Kendrick, E. T. Abbott and M. D. Rhawn.

Sewers and Drainage—F. W. Carr and C. W. Redfield.

Engineering Jurisprudence—John Lamb.

Building Material and Sanitation—Fred. Keyes, J. M. Hogan and G. Sidney Houston.

Rivers and Canals—D. P. Waters, G. W. Sturtevant and F. H. Todd.

Streets and Paving—George W. Cooley and C. E. Sprague.

Surveying and Topography—F. L. Shaw, A. C. Libby and Frank Plummer.

Weights and Measures—W. S. Pardee, Robert Augst and Edward Barrington.

Machinery—R. H. Sandford, J. H. Barr and William de la Barre.

Water Supply—J. Waters and D. P. Waters.

Municipal Engineering—Andrew Rinker, William de la Barre, E. T. Abbott and William Van Duzen.

Contracts and Management of Work—P. B. Winston.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the Club House in Philadelphia, Feb. 19, President T. M. Cleemann in the chair; 34 members and 1 visitor present.

Mr. John Fernie, C. E., Member Institute of Civil Engineers, Institute of Mechanical Engineers, etc., of England, delivered an entertaining and instructive address upon the Mechanical Genius and Works of the late Sir Joseph Whitworth.

A REGULAR meeting was held at the Club House in Philadelphia, March 5, President T. M. Cleemann in the chair; 15 members and 1 visitor present.

Mr. S. L. Kneass presented an illustrated description of a new Fixed Nozzle Automatic Injector which will restart itself, if from any cause its supply of water or steam be temporarily interrupted. It is especially designed for locomotive service, where its power of adapting itself to varying steam pressures and its automatic action are especially desirable. He closed with a few remarks on the theory of the action of the injector and its efficiency.

Mr. R. W. Lesley presented illustrated notes upon the manufacture of Cement in the United States and the Growing Demand for High-class Mortars. The Secretary presented, for Mr. Theodore J. Lewis, a paper upon 3-in. *vs.* 4-in. tires for locomotives.

The Secretary presented, for Mr. A. P. Broomell, an illustrated description of the Large Engines being built to drive

the Centrifugal Pumps for reclaiming the Potomac Flats, Washington, D. C.

The Secretary also presented, for Mr. Broomell, a copy of an Ice Machine, which he had designed with a view of overcoming some of the objectionable features in previous machines.

The Secretary presented sundry announcements as to current business and correspondence.

Western Railway Club.

THE regular monthly meeting was held in Chicago, March 16, President Scott in the chair. The regular subject, Car Heating, was taken up.

Mr. Forsythe opened the discussion in a long address, in which he expressed the opinion that all forms of stoves and heaters would, in the end, have to give way to some system of continuous heating. He believed that the increase in grate surface and boiler capacity of locomotives would enable them to meet the demand for steam for heating purposes. The great objection to continuous heating, in his mind, was the difficulty of heating cars when detached from the locomotive, and he believed that that could be met.

The Sewall, the Harrington, the Herr and the Cline systems of heating were then described at length by their inventors or representatives.

Letters were read from Mr. Johann describing the means he had taken to make heaters safe; from Mr. Lowry, describing the Martin system, and from Mr. Hickey, describing the difficulties encountered on far northern roads, subject to interruption by snow.

Mr. Gibbs described the experience had with the Martin heater on the Chicago, Milwaukee & St. Paul road, the results so far being favorable. He thought that further experiments would be needed to settle the question, as the trial this season had been short.

After some discussion the following resolution was passed:

"That it is the sense of the members of the Western Railway Club that it would be advisable for railway companies to investigate thoroughly and experiment with continuous steam heating of passenger trains; and that a committee of three be appointed to endeavor, through the managers or general superintendents of some of the prominent railroads running into Chicago, to equip trains on different roads with different devices."

It was explained that this resolution was intended to refer only to continuous heating methods, but not to discourage experiments by individuals or roads in any direction they pleased.

The rules of interchange were then taken up, beginning with Rule 21. On motion of Mr. Meade the following sentence was recommended to be added to Rule 21:

"If new standard parts mentioned in Rule 15 be more expensive than original construction, allowance shall be made for the same as may be agreed upon."

Rules 22 to 29 were passed without alteration.

Mr. Meade moved that in Rule 30 the words "or in process of purchase," be stricken out. Carried.

Mr. Rhodes submitted the statement of the committee appointed at the January meeting to report on the height of empty freight cars from the center of draw-bar to top of rail of all roads having representative members in the Association.

The subject for discussion at the April meeting will be the report of the Committee on Interchange Rules.

New England Railroad Club.

THE regular March meeting, which was also the fourth annual meeting, was held at the Club Rooms in the Boston & Albany station in Boston, on Wednesday evening, March 9. There was a very large attendance.

The Secretary and Treasurer, Mr. J. M. Ford, presented his annual report, showing that the cash on hand at the beginning of the year was $131; received from dues, $316; total, $447; expenditures, $296; leaving a balance of $151. The present membership is 176, a gain of 17 over the previous year. The average attendance at the monthly meetings has been 113.

The nominating committee appointed at the February meeting presented a list of officers, and the following were elected for the ensuing year: President, J. N. Lauder; Vice-President, George Richards; Secretary and Treasurer, F. M. Curtis; Executive Committee, J. N. Lauder, F. D. Adams, J. W. Marden, J. K. Taylor, J. M. Ford, A. M. Wait, Albert Griggs, J. T. Gordon; Finance Committee, James Smith, Charles W. Sherburne, A. G. Barber, Isaac N. Keith, Robert Johnson, Joel H. Hills, Daniel S. Page.

The routine business being completed, the subject for discussion—Lighting and Ventilating Cars in Passenger Service—was taken up.

A communication from Mr. J. M. Foster, describing his system of lighting by means of compressed gas, was read by the Secretary. A recess of 10 minutes was then taken to enable the gentlemen to personally inspect the Jullien system of lighting by electricity from storage batteries, as exhibited on car No. 90 of the Boston & Albany Railroad. This system is described elsewhere.

After the inspection, Mr. Fowler and Mr. Reed explained the system and its workings, answering questions which were asked in relation to it.

Ex-Gov. Howard, Superintendent of Tests at the Watertown Arsenal, explained the Pintsch system of lighting with gas, stating that 22,000 cars are thus lighted, mostly in Europe.

Mr. Thomas Wise then explained a system of ventilating by means of a fan-blower run from the car-axle, and a plan of electric lighting by means of a dynamo, also run from the car-axle.

President Lauder said he was glad so much valuable information had been given on the subject of lighting, and while he thought electric light was to be the future light, he said at the present time there are no data to show the actual cost, but it now looks as though it is far too heavy for most roads to put in operation.

On motion of Mr. Marden, it was voted to continue the same subject for discussion at the next meeting. The Club then adjourned.

Master Car-Builders' Club.

THE regular monthly meeting was held at the rooms, No. 113 Liberty street, New York, on the evening of March 17, Mr. C. E. Garey in the chair.

Mr. C. E. Garey was unanimously chosen Chairman of the Club (in place of the late Leander Garey) and returned thanks in a brief speech.

The subject—Car Heating, Lighting and Ventilation was then taken up.

Mr. Woodward explained the construction and operation of the Sewall system of heating trains by steam from the locomotive, and also gave some notes of the results obtained on the Maine Central road. He said that the company was fitting up two trains for the Fitchburg road, one for the Michigan Central and one for the New York & New England. The present cost is about $300 per car.

The Frost heater, which is so arranged that in case of any disturbance of equilibrium the fire drops into a tank full of water, was then shown, the inventor giving a practical demonstration by upsetting his heater, the result being a general wetting of feet and much sneezing as smoke and gas filled the room.

The Condon heater was then shown, the safety claimed in this case being due to careful construction, double doors, etc.

President Ladder, of the New England Club, being in the room, was called for and made a brief address, in which he urged the necessity of work to keep up the standard of the Club. Mr. Lauder also spoke at some length on the question of heating. He said that there was a demand for systems of continuous heating, and urged the importance of adopting some uniform system of coupling for the steam pipes on the cars. He further spoke of the uselessness of applying safety systems to the passenger cars and leaving an old cast-iron stove in the baggage car, where it was peculiarly subject to accident.

Mr. M. Hurley, of Quebec, then made an address in which he claimed to be the first inventor of a system of steam heating.

The Plass system of heating by gasoline was then explained. To this, the objection was urged that gasoline was extremely dangerous to store or carry in quantities.

The Pennock system of electric lighting was then explained. In this, a storage battery is used, the battery intended to supply 10 lights of 10-candle power weighing about 1,000 lbs., and needing recharging once a week. This system is to be tried on the Baltimore & Ohio, the Delaware & Hudson, the New York Central and the Manhattan Elevated lines.

Mr. Lauder spoke of the Jullien system of electric lighting, now on trial on the Boston & Albany road; in this, the battery weighs 1,800 lbs.

Owing to the lateness of the hour the discussion was closed, and the meeting adjourned.

At the April meeting the subject for discussion will be the same—Heating, Lighting and Ventilating Passenger Cars.

PERSONAL.

bell Breckenridge is Division Engineer of the new Tennessee Midland road.

Mr. C. C. Chandler has been appointed Chief Engineer of the Ohio & Mississippi road.

Captain John A. Kress has been promoted to be Major of Ordnance in place of Parker, promoted.

Mr. J. W. Robinette has been appointed Chief Engineer of the Elizabeth & Hodgensville Railroad.

Mr. James J. Todd has been appointed Assistant Roadmaster of the New London Northern Railroad.

Lieutenant F. P. Gilmore, U. S. N., has been ordered to duty as Inspector of steel for the new cruisers.

Mr. H. Pierce is appointed Engineer of Maintenance of Way of the Cincinnati, Hamilton and Dayton road.

Mr. Stacy B. Opdyke has resigned his position as Superintendent of the New Haven & Northampton Railroad.

Mr. C. S. Dwight, of Winnsboro, S. C., is Division Engineer on the New Georgia, Carolina & Northern road.

Lieutenant Charles L. Potter has been transferred to the Corps of Engineers in place of C. E. Gillette, promoted.

Mr. W. Bell Dawson has been appointed Assistant City Engineer of Toronto, Ont., by the Board of Public Works.

Mr. W. McLeod has been appointed General Roadmaster, with charge of the Kansas divisions of the Missouri Pacific.

Mr. E. Holbrook has resigned his position as Division Superintendent on the New York & New England Railroad.

Major Francis H. Parker has been promoted to be Lieutenant Colonel of Ordnance in place of Whittemore, promoted.

Mr. Lyman Anderson is Engineer in charge of the construction of new and extensive iron-pipe works at Birmingham, Ala.

Lieutenant Colonel James M. Whittemore has been promoted to be Colonel of Ordnance in place of McAllister, deceased.

Mr. W. B Ruggles, Chief Engineer of the Ohio & Mississippi Railway, has resigned that position, dating from March 1.

Mr. J. F. Morrison, of Athens, Ga., has been appointed Chief Engineer of the projected Georgia, Carolina & Northern Railroad.

Mr. James Harrington has been appointed Chief Engineer of the Cleveland, Akron & Columbus road, with office at Akron, Ohio.

Mr. L. O. Gassett has resigned his position as Master Mechanic of the Erie Division of the Lake Shore & Michigan Soulhern road.

Mr. John P. Ray, for some years General Foreman of the Union Pacific shops at Omaha, has resigned and will go into other business.

Mr. William Patterson has been appointed Master Car Builder of the Minnesota & Northwestern road, with office in St. Paul, Minn.

Mr. C. H. Blakesley has resigned his position as Master Mechanic and Assistant Superintendent of the Western Railroad of Florida.

Mr. L. F. Wakefield has been appointed Chief Engineer of the projected Sioux City & Northeastern road, with office at Sioux City, Iowa.

Mr. C. K. Lawrence has been appointed Engineer of Maintenance of Way of the St. Paul, Minneapolis & Manitoba road, with office in St. Paul.

Mr. C. J. Bechdolt has been appointed Assistant Engineer of the Middle Division of the Pennsylvania Railroad in place of C. K. Lawrence, resigned.

Mr. Edward Barrington has been appointed Chief Engineer of the Wichita, Cedarvale & Southeastern, a road in Kansas. His office is at Wichita.

Mr. D. Horrie has been appointed Superintendent of Bridges of the Milwaukee, Lake Shore & Western road, with headquarters at Kaukauna, Wis.

Mr. J. S. Graham has been appointed Master Mechanic of the Erie Division of the Lake Shore & Michigan Southern road in place of L. O. Gassett, resigned.

Mr. Alexander Abend has been appointed Division Engineer on the new Tennessee Midland road, and will be located for the present at Knoxville, Tenn. He has been for some time Engineer of the Belleville (Ill.) Water Works.

Mr. Emil Swensson, formerly Assistant Engineer of the South Pennsylvania Railroad, is now in the office of the Phœnix Bridge Company at Phœnixville, Pa.

Mr. T. Hartman has resigned his position as Assistant to the President of the Memphis & Little Rock road, and will go into business as a railroad contractor.

Mr. John Duffy has been appointed Master Mechanic of the Toledo, Columbus & Southern Railroad, with office at Toledo, O., succeeding Mr. H. S. Herrick.

Mr. Marriott C. Smyth has resigned his position as Secretary and Treasurer of the Midvale Steel Works in Philadelphia after 20 years' service with the company.

Mr. J. H. Burnett has been appointed Master Mechanic of the Jacksonville, Tampa & Key West Road. He was recently on the Louisville & Nashville road.

Mr. J. S. Ward has been appointed Engineer of the North Penn & Bound Brook Division of the Philadelphia & Reading Railroad in place of Mr. E. Chamberlain, resigned.

Mr. E. J. Roberts has been appointed Chief Engineer in charge of the St. Paul, Minneapolis & Manitoba Extension into Montana, which is to be built during the present year.

Mr. H. Spidel, of Rock Island, Ill., has been appointed Chief Engineer of the Memphis, Trinidad & Pueblo, a projected road, and will have his headquarters at Greensburg, Kansas.

Mayor Smith, of St. Paul, Minn., has appointed the following to be members of the New Board of Public Works: John C. Quimby, Richard L. Gorman, William Barrett and Edward C. Starkey.

Mr. Samuel Oakley has been appointed General Car Foreman of the St. Paul, Minneapolis & Manitoba road, with office at St. Paul, Minn. He was recently on the Canadian Pacific road.

Mr. Charles O. Haines has been appointed Superintendent of the new Savannah & Tybee Railroad. He is a son of Mr. H. S Haines, General Manager of the Savannah, Florida & Western road.

Col. George E. Waring has been appointed Consulting Engineer to the city of San Diego, Cal. His plans for the sewer system of the city have been adopted with some slight modifications as to the outlet.

Mr. S. M. Rowe has been appointed Resident Engineer of the Atlantic & Pacific Railroad, with headquarters of Albuquerque, N. M. He will have charge of maintenance of way, bridges, buildings and water service.

Mr. E. J. Blake has been appointed Chief Engineer of the Hannibal & St. Joseph and the Kansas City, St. Joseph & Council Bluffs railroads in place of Mr. C. C. Chandler, who goes to the Ohio & Mississippi road.

Mr. Charles Howard has been appointed Superintendent of the Providence & Worcester Railroad, in place of W. E. Chamberlain, resigned. Mr. Howard was recently on the Worcester Division of the Fitchburg road.

Mr. William E. Chamberlain has resigned his position as Superintendent of the Providence & Worcester Railroad. He has been on that road for some 10 years, and was previously Master Car-Builder of the Boston & Albany.

Mr. Axel S. Vogt has been appointed Mechanical Engineer of the Pennsylvania Railroad in place of Mr. John W. Cloud, who has gone to the New York, Lake Erie & Western road. Mr. Vogt has been with the company for some time.

Mr. George H. Watrous has resigned his position as President of the New York, New Haven & Hartford Railroad Company. He has held the office since 1879, and was previously Counsel of the company. He retires on account of ill health.

Mr. James C. Bayles has been appointed President of the New York Board of Health by Mayor Hewitt in place of Gen. Shaler, removed. Mr. Bayles is Editor of the *Iron Age*, and is well known as a writer of ability on sanitary and construction topics.

Mr. John Robinson has been appointed Master Mechanic of the Buffalo Division of the Lake Shore & Michigan Southern road in place of J. S. Graham, transferred to the Erie Division. Mr. Robinson has been for some time Foreman of the Engineeouse at Elkhart.

Mr. John E. Fry, formerly Manager of the Bessemer Steel Department of the Cambria Iron Company, and recently Superintendent of the St. Louis Ore & Steel Company, has been appointed Manager of the Wheeling Steel Works at Benwood, W. Va. These works were built to make Bessemer steel for several companies in Wheeling.

Mr. C. A. Thompson has been appointed General Inspector of Motive Power and Equipment of the Philadelphia & Reading Railroad, and will have his headquarters at Reading, Pa. Mr. Thompson was recently Master Mechanic of the Long Island Railroad.

General William J. Sewell, the retiring Senator from New Jersey, who was an unsuccessful candidate for re-election, was for a number of years Superintendent of the West Jersey road. For several years past he has been Vice-President of the Company.

Mr. L. Redfield has taken charge of *Wood and Iron*, published at Minneapolis, Minn., in place of Mr. W. R. Gregory. Mr. Gregory has sold his interest in the paper to some Minneapolis gentlemen, who will put new capital into the paper, and make many improvements.

Mr. James Arkell, of Canajoharie, has been nominated by the Governor of New York as Railroad Commissioner, in place of John O'Donnell, whose term has expired. Mr. Arkell was not confirmed by the Senate and his nomination was withdrawn.

Mr. William O. Seymour has been appointed Railroad Commissioner by the Governor of Connecticut, in place of Mr. John W. Bacon, whose term has expired. Mr. Seymour is a civil engineer, and was for nine years Chief Engineer of the New York, New Haven & Hartford road.

Mr. S. Wright Dunning, for many years Editor of the *Railroad Gazette*, has met with a double bereavement in the death of his father, Josiah D. Dunning, and his mother. Both died on the same day and within two hours, at their home in Aurora, Ill., March 1 last. Both were 84 years old.

Capt. Chas. W. Rogers, First Vice-President of the St. Louis & San Francisco road, died at Pasadena, Cal., Feb. 21, after a long illness. He was 52 years old and had been connected with the road 15 years, serving successively as Purchasing Agent, General Superintendent, General Manager and Vice-President.

Mr. Charles P. Clark has been chosen President of the New York, New Haven & Hartford Railroad Company. He has been a director of the company for several years, and was Second Vice-President for a year. He is best known from his service as President and Receiver of the New York & New England Railroad Company.

Col. A. S. Buford, for a long time President of the Richmond & Danville Railroad Company, is now President of the Virginia Western and the Tennessee Midland, two companies organized to build a railroad from Memphis, Tenn., to a connection with the Shenandoah Valley and the Richmond & Allegheny in the valley of Virginia.

Mr. Rufus Blodgett, who has been elected United States Senator from New Jersey, was for a number of years Master Mechanic of the New Jersey Southern road, and afterwards Superintendent of the same line. For two years past he has been Superintendent of the New York & Long Branch road. Mr. Blodgett has served several terms in the State Legislature.

Mr. George H. Griggs is appointed Master Mechanic of the Central Railroad of New Jersey, with office at Elizabethport, N. J., in place of the late William Woodcock. Mr. Griggs was for a number of years at Hornellsville, N. Y., in charge of the Western and Buffalo divisions of the Erie road. For several years past he has been Master Mechanic of the New York, Providence & Boston road.

Professor Arthur T. Hadley, who has for two years past filled the office of Commissioner of Labor Statistics of Connecticut in a very efficient manner, has retired from that office, the present Governor of the State having appointed as his successor Mr. Samuel N. Hotchkiss. The new Commissioner lacks Prof. Hadley's special qualifications for the office, and has been appointed, apparently, for political reasons only.

Mr. Michael J. Rickard, of Utica, has been nominated by Governor Hill, of New York, for Railroad Commissioner in place of John O'Donnell, whose term has expired. The Governor has withdrawn his previous nomination of Mr. James Arkell. Mr. Rickard is a locomotive engineer on the New York Central and a member of the Brotherhood of Locomotive Engineers. His nomination has not yet been confirmed by the Senate.

Mr. James D. Layng has been chosen President of the Cleveland, Columbus, Cincinnati & Indianapolis Company. He was for a number of years on the Pittsburgh, Fort Wayne & Chicago. From that road he went to the Chicago & Northwestern as General Superintendent. He left the Northwestern to become General Superintendent of the West Shore, and afterwards succeeded Mr. Charles Paine as General Manager of that road.

Colonel Henry G. Prout has been added to the staff of the *Railroad Gazette*, and will be Managing Editor of that paper. Colonel Prout is a civil engineer by education; he was for several years in the service of the Khedive of Egypt, rising to the rank of Colonel in the Egyptian army. He has for some time past had charge of the *Journal* of the Association of Engineering Societies, and has had other practical experience which well fits him for his new position.

General Louis Wagner has been appointed Director of Public Works of Philadelphia. Under the new charter of the city this officer has sole charge of the streets, sewerage, water-works, gas-works, and other departments, and is responsible directly to the Mayor, by whom he is appointed. General Wagner has had much experience in city offices and public works, but is not, we believe, an engineer by training. The appointment seems to meet with local approval.

Shunk & Bryson is the title of a new firm of civil engineers just formed, whose office is established at No. 1 Broadway, New York. The specialties of the firm will be surface and elevated railroads, reports on projected enterprises, the conduct of surveys, location and economical building of roads, preparation of plans and estimates, and superintendence of construction. They will also prepare plans for sewerage and water supply, grading streets, etc., and for bridges and buildings, and do a general consulting business.

Mr. William F. Shunk, the senior partner, has had a wide experience, and is well known both in active service, as engineer in charge of the construction of railroads and other works, and as a writer on engineering topics. He was Chief Engineer in charge of the construction of the Metropolitan Elevated Railroad in New York, and more recently Associate Chief Engineer of the South Pennsylvania Railroad.

Mr. Andrew Bryson has also had much experience in railroad and other work. He was Chief Engineer of the Hartford & Harlem road, and more recently Engineer in charge of the construction of the Kings County Elevated road in Brooklyn.

NOTES AND NEWS.

German Iron Production.—The total production of pig-iron in Germany in 1886 was 3,339,803 tons, against 3,751,775 tons in 1885; a decrease of 411,972 tons, or 11 per cent.

Prices of Cars.—At a recent letting by the Texas & Pacific contracts for a large number of freight cars were given out at the following prices. Flat and gondola cars, $320 to $350; stock cars, $475; box cars $475 to $500 each.

Electric Elevators.—The Sprague Electric Railway & Motor Company, it is said, is running 13 elevators in Boston, both freight and passenger. One of the freight elevators is the largest in the city. They also have 50 other motors in operation.

Hudson River Tunnel.—The New Jersey end of the incomplete tunnel under the Hudson River was pumped clear of water some time ago, and arrangements are in progress to resume work. How soon this is done, or whether it is done at all, depends upon whether the money can be raised.

Triple Expansion Engines on Lake Steamers.—The Cleveland Shipbuilding Company has let contracts for the engines of a new lake steamer which it is now building. The engine is of the triple-expansion class, the cylinders being 24, 38 and 61 in. diameter and 42 in. stroke.

A New Iron Vessel.—At the yard of the Harlan & Hollingsworth Company in Wilmington, Del., on March 21, the new iron steamer *George* was launched. The vessel is 280 ft. long between perpendiculars, 292 ft. over all, 40 ft. beam and 17½ ft. depth of hold; it is to run on the Bay Line between Baltimore and Norfolk.

Repaving New York Streets.—A movement is on foot, it is said, to repave a large number of the streets of New York. This work is certainly much needed. The persons who are urging it believe that the present is a good time to undertake it, especially as the department of Public Works is now under so able a head as Gen. Newton.

Arthur Kill Bridge.—The Secretary of War has authorized the building of the bridge over the Arthur Kill on the Baltimore & Ohio line to Staten Island, on the original plan, subject to the requirements of the rule laid down by the War Department in July, 1886. The bridge, according to the plan, will have four fixed spans and a draw-span.

Alabama School of Mines.—The Board of Trustees of the

University of Alabama have decided to establish a school of mines in connection with the University. A full course of instruction in mining and metallurgy will be arranged. This action is particularly appropriate in Alabama, whose mineral resources are great and are just beginning to be developed.

Wrought-Iron Car Wheel-Centers.—The Secretary of the Treasury has decided that car-wheel centers, consisting of iron forgings which have been advanced by other processes of manufacture—bored out for the axle, hubs faced, rims turned and finished, with a flange or rim bolted on to prevent slipping of tires—but not completed by putting on the tires, are subject to duty at the rate of 45 per cent. *ad valorem*.

A Large Bronze Casting.—The Henry Bonnard Bronze Company in New York recently made what, it is claimed, is the largest bronze casting ever made in America. The casting is part of an equestrian statue of General Meade, for Philadelphia. In making it 7,500 lbs. of metal were used, the composition being 90 parts copper and 10 parts tin. The statue when finished will be 16 ft. high, and weigh about 10,000 lbs. in all.

Railroad Bridges in Massachusetts.—The Massachusetts Railroad Commission on March 21 sent out the following circular: "To the Managers of the Several Railroads in Massachusetts: You are requested to send to this office, at the earliest practical moment, the strain sheets and records of the first and latest tests of all the bridges on the roads operated by you. State also whether any parts of said bridges which are essential to safety are so covered as to be concealed from inspection. Describe also the style of flooring."

Mineral Products of Ohio.—Mr. Thomas B. Bancroft, Chief Inspector of Mines of Ohio, makes the following statement of the products of that State for 1886.

Coal, tons	8,435,211
Iron ore, tons	344,484
Limestone, tons	625,350

The limestone is only that used for flux in smelting iron or burned for lime, the large quantity quarried for building and paving purposes not being included. Coal was mined in 28 counties and iron ore in 14 counties.

Old Bridges and Modern Engines.—The Maine Railroad Commissioners in their last report call attention to the fact that on the railroads of that State there are many bridges which, while they may have been well designed in the first place and well taken care of since, were yet intended for locomotives very much lighter than those in general use at the present time. Whether these bridges are safe under the rolling stock now in use, and whether they are not overloaded and subject to failure at any time, are serious questions, the Commissioners think, and should be carefully considered.

Rapid Transit in New York.—Mayor Hewitt, of New York, has appointed Messrs. Jackson S. Shultz, H. K. Thurber, Walter Stanton, E. Ellery Anderson and William E. Worthen, C. E., Rapid Transit Commissioners to lay out routes for steam-railroad connections between the elevated roads and the ferries, south of Fourteenth Street. The plan proposed by the Manhattan Company is for a line along the North River front from the Battery to Christopher street, connecting with the Sixth Avenue line on the west side, and a loop from the Third Avenue line along the East River from Chatham Square to the Battery.

Blast Furnaces of the United States.—The *Iron Age* reports the number of furnaces in blast on March 1 as follows:

Fuel.	No.	Weekly capacity.
Anthracite	141	43,724
Bituminous	146	79,682
Charcoal	51	9,546
Total	338	132,952

As compared with January 1, there was an increase of 11 anthracite and 9 bituminous furnaces in blast, with no change in the charcoal furnaces.

Bessemer Steel Production in England.—The British Iron Trade Association reports the total production of Bessemer steel ingots in Great Britain in 1886 at 1,570,520 tons, an increase of 20½ per cent. over 1885.

Of the production last year 730,343 tons, or about 46 per cent., were converted into steel rails. The increase in rail production over 1885 was small, being only 3¾ per cent.

Of the total output of Bessemer steel ingots 723,337 tons were made in the first half of the year, and 837,183 tons in the second half, showing an increase in activity which continued up to the close of the year.

A Fast Yacht.—The Herreshoffs, at Bristol, R. I., have contracted to build, for a New York gentleman, a steam-yacht, which is to make greater speed than any heretofore built. She will be 100 ft. long, and in general dimensions about the same as the *Stiletto*, built last year by the same parties.

The builders have guaranteed a rate of speed in excess of that of the *Stiletto*, which has attained 26 miles an hour over the measured mile. The yacht will be arranged for comfortable cruising as well as immense rapidity of motion. Her engines will be of the triple expansion type, thus differing from those of the *Stiletto*, which have two cylinders only. The work is to be rushed so that the new craft will be ready for service the latter part of June.

Bridge Contracts.—The Edgemoor Iron Company, Edgemoor, Del., has taken the contract for the superstructure of the bridge over the Missouri River, on the Atchison, Topeka & Santa Fe Extension to Chicago. The bridge will have three spans of 400 ft. each over the channel, one span of 250 ft., one of 200 ft., and two of 175 ft. each. In the approaches there will be 1,900 ft. of iron trestle. There will be no draw, the bridge being 95 ft. above low water in the river.

The bridge over White River, at West Hartford, on the Central Vermont road, which was burned down in the recent accident, will be replaced by a riveted lattice deck bridge, 650 ft. long, in five spans. The Vermont Construction Company, of St. Albans, will build the bridge.

A Large Anvil Block.—The Otis Iron & Steel Company recently made a steel anvil block, which is said to be the largest steel casting ever made in this country. The block is for a steam hammer which the Morgan Engineering Company is building for the Otis Company's works. It weighs 68,200 lbs., is 8 ft. square and 3 ft. 10 in. high. The analysis in carbon is 0.12 to 0.15. The quality of the steel is about the same as that of the company's soft open-hearth steel, no special effort being made to have the metal free from blow-holes. The steel was melted in two furnaces, and the total amount charged was 78,525 pounds. The total time of pouring the block, from the time the metal commenced to run from the first furnace until all the metal was in the mold, was 4 minutes and 20 seconds.

Iron Forges.—The *Bulletin* of the American Iron & Steel Association says: "The primitive manner of making wrought iron from ore in forges, practiced chiefly in the Lake Champlain District of New York and in the mountainous districts of North Carolina and Tennessee, is fast becoming a thing of the past. The quantity of iron made by the New York forges is decreasing yearly. In North Carolina the Maiden Creek Forge has rotted down; the Catawba Valley Iron Works are suspended; Owl Creek Forge, at Murphy, Cherokee county, will make no more blooms, and the owner, Mercer Fain, desires to let the valuable ore and timber lands connected with the forge. The other forges in that part of the State are not in operation. Very little iron was made in the Tennessee forges during 1886."

Georgia Technological School.—This school is to be located in Atlanta, instead of at the State University at Athens, the Commission having decided that a city presents better opportunities for technical instruction.

The funds provided and ready for the building and its appointments are as follows: From the State, $65,000; from the city, $50,000; from the citizens of Atlanta, $20,000; total $135,000. The Institution will also have an annuity of $25,000, with which Atlanta has endowed it for a period of 20 years.

The various details, including the erection of the buildings, purchase of machinery and all other appointments, and the final selection of instructors will receive the closest attention on the part of the Commission, the intention being to make the school one of the best of its kind

Steel for Guns and Armor Plates.—On March 22, at the Navy Department in Washington, the bids for furnishing armor plates and heavy steel forgings for guns were opened. Five bids were received, three for the gun forgings and two for the armor plates. The bids for the gun-steel (1,310 tons) were as follows:

Midvale Steel Works, Philadelphia	$1,397,240
Bethlehem Iron Company, Bethlehem, Pa	902,231
Cambria Steel & Iron Company, Johnstown, Pa	851,514

For the armor plates (4,500 tons), the bids were as follows:

Bethlehem Iron Company, Bethlehem, Pa	$3,610,708
Cleveland Rolling Mill Company, Cleveland, O	4,021,560

The Bethlehem Iron Company offers to have its forging plant completed in 15 months, or half the time required by the Department. The contracts have not yet been awarded, and the decision will probably not be made public until the middle of April.

The Berdan Torpedo Boat.—Gen. Berdan recently exhibited in Washington a working model of his torpedo boat, which is intended to do effective service in cases where other

forms of torpedo have failed—that is, where the craft attacked is protected by a network of chain suspended beyond the hull by spars. The model is that of a vessel 150 ft. in length, 20 ft. in breadth and 16 ft. in depth, and intended to attain a speed of 24½ knots an hour. The novel feature of the craft consists of a pair of brass tubes arranged vertically on the sides and opening downward, capable of firing torpedoes containing 200 lbs. of dynamite or other high explosives. These torpedoes are connected with a cross-piece on the bow by stout steel cables: When the projecting spar, corresponding to an ordinary bowsprit in appearance, comes in contact with the hull of the vessel attacked, it automatically reverses the engine and fires the 100-lb. charges of rocket powder in the torpedo cases. The torpedoes are driven downward, but yielding to the direction imparted by the cables, swing around under the protective netting and strike beneath the keel of the attacked vessel, exploding their charges by percussion directly under its botom.

Shipbuilding in Great Britain.—The number of new vessels built in Great Britain in 1886 and registered there was as follows:

	Steam		Sail		Total	
	No.	Tons.	No.	Tons.	No.	Tons.
Steel	124	162,073	31	30,588	155	192,661
Iron	119	82,201	55	97,713	174	179,914
Wood	30	1,467	229	14,411	259	15,878
Total	273	245,741	315	142,712	588	388,453

The wooden vessels, it will be seen, were generally of small size, averaging only a little over 60 tons each.

The total tonnage of vessels built as reported to the British Iron Trade Association, was 481,233 tons. The difference between this and the statement given above is accounted for by the fact that 80,701 tons were built for foreign account, and not registered in Great Britain, while several vessels launched near the close of the year were not registered until 1887. The total tonnage built shows a decrease of 11 per cent. from 1885.

The total number of steel vessels built in 1886 for home and foreign account was 219, with a total tonnage of 265,460; an average of 1,213 tons per vessel.

Plans for Car Heating Wanted.—The Acting Secretary of the Treasury has issued the following circular "to whom it may concern:"

"Congress (House of Representatives) having, on Jan. 21 last, by resolution, requested the Secretary of the Treasury to make inquiries of constructors of passenger cars and of steamboats, and of other persons capable of giving useful information as to the best methods of building railroad cars and heating the same, and constructing steam vessels so as to prevent loss of property and life by fire, the Department takes this method of inviting correspondence upon the subject matter of the resolution referred to. Parties offering suggestions are requested to send with them sketches or drawings of their designs when practicable.

"All communications upon the subjects referred to herein should be addressed to the Secretary of the Treasury, Washington, D. C., also indorsing upon the outside 'Plans for heating railroad cars, etc'

"Communications received after Nov. 1, proximo, will not be guaranteed consideration, as a report will have to be made to Congress at the commencement of the session in December."

Iron Ore Supply.—Major John W. Powell, Director of the United States Geological Survey, has furnished the following for publication:

"The great increase in the production of pig-iron, from 4,529,869 short tons in 1885, to 5,600,000 short tons during the year 1886, has led to much inquiry as to the source of the ores which made this increase possible, for it is a well-known fact that even the ordinary production is a drain upon the ore deposits sufficient to exhaust the present sources of actual supply in a short period—perhaps in 30 years, more probably in much less time. The Government has given sufficient attention to the general geology of the country, however, to afford a good grasp on the distribution of the iron ores, and the geologists have also defined the character of the ores so well as to direct the explorers accurately to the profitable fields. The statement was made last year by me that within 30 years the necessary exploration for new iron-ore mines would exceed that of Great Britain, where every available deposit is being traced to the farthest extent. The years 1885 and 1886 have shown the justice of this prediction in the development of new fields to support the increased production. The new Gogebic District, which produced 1,022 tons in 1884, increased to 111,661 tons in 1885, and increased this fourfold in 1886, has been the scene of unparalled developments, and the same is true of the Vermilion District of Minnesota. The confidence with which capital has been invested in these new claims is due to the advice of the geologists to extend the mines in this direction. That the new mines are the result and not the cause of the increased production of iron and steel is shown by the increased imports of Spanish ores during the last year as the result of higher prices. This shows that the remedy for prospective exhaustion is still further exploration for the mines to which the geologist points in various parts of the country. Many of the large deposits have been neglected as not suitable for making steel by the ordinary process, and in others others the percentage of iron is not attractive. But much attention will undoubtedly be given to these ores within the next few years. This tendency is seen at one locality in Tennessee by the increase from 70,757 long tons in 1884 to 94,319 long tons in 1885, and even the silicious ores at Cornwall, Pa., show increased use."

Electric Light for Cars.—The Boston & Albany Company, having had a passenger car in service lighted with the electric light, has decided, it is said, to equip a large number of cars in the same way. The trial car (and the others are to have substantially the same apparatus) carries 24 incandescent lamps of 16-candle power each, the power for these lamps being furnished by a Jullien storage battery carried underneath the car. This storage battery will keep all the lights burning for 10 hours; it has 60 cells, each cell consisting of 19 plates, weighing in all 27 lbs., and measures 6½ by 5¾ in., and 8 in. high. These cells are combined in boxes for convenience in carrying and changing, and the whole battery weighs about 1,800 lbs.

The car is lighted brilliantly, and in ordinary service a smaller number of lights would be sufficient. In a month's service there has been no trouble whatever with the lights, and it is claimed that the work necessary to recharge the batteries is much less than that required to take care of lamps, while the cost is no greater.

The apparatus was furnished by the Jullien Electric Light Company, of New York, which owns the patents covering the Jullien storage battery in this country. That company is equipping cars for the Baltimore & Ohio, the New York Central and the Pennsylvania roads, and the new system is to have a trial on all those lines.

Interstate Commerce Commissioners.—President Cleveand has appointed the following Commissioners under the Interstate Commerce law, which takes effect April 5: Judge Thomas M. Cooley, of Michigan, for six years; Hon. Wm. R. Morrison, of Illinois, for five years; Augustus Schoonmaker, of New York, for four years; Aldace T. Walker, of Vermont, for three years; Walker L. Bragg, of Alabama, for two years.

Judge Cooley was for 15 years a member of the Michigan Supreme Court; he was for a time Arbitrator of several of the Western traffic associations, and is now Receiver of the Wabash, St. Louis & Pacific lines east of the Mississippi. He is considered high authority on railroad law and traffic questions.

Colonel Morrison is well known from his service of 16 years in Congress, where he has taken a prominent part.

Mr. Schoonmaker has served as State Senator and Attorney General of the State of New York, and is a lawyer of high standing.

Mr. Walker is also a lawyer of high standing. He was for some time Counsel for the Vermont & Canada stockholders in their long fight against the Vermont Central Receivers and the Central Vermont.

Mr. Bragg has been for four years Chairman of the Alabama Railroad Commission, where he has done excellent work.

Power Brakes for Locomotives.—Mr. James Hilbert, of Division 263, writes to the *Journal* of the Brotherhood of Locomotive Engineers as follows:

"In common with a great number of our Brotherhood I am pleased to see the rapid introduction of power brakes for locomotives, and how generally they are now coming into use. I have had an improved form of steam-brake upon the engine which I am running now for several months, and have already had several opportunities of observing its usefulness. I will relate one instance which happened with me quite lately and which will illustrate the advantage of such a device upon the engine. A short time ago I was coming down the mountain with my engine light, and I saved a runaway with the brakes on my engine in this manner: A train of engine and 75 cars was following me, and their hand brakes could not hold the train, when the engineer reversed the engine and blew both of his steam chests off. I saw the situation and prepared to see what virtue there was in my steam driver and tender brake, so I governed the speed of my engine until they came against me, when I stopped the whole outfit in a very short distance with my steam brakes, in time to save running into another train

ahead of me, and thus averted what might have resulted in a terrible smash-up all around. I believe that all engines upon the roads should be provided with effective power brakes, especially these heavy mogul and consolidation engines which are coming into such general use."

The Bussey Bridge Accident.—On the morning of March 14, as a local train (locomotive and nine cars), on the Dedham Branch of the Boston & Providence road was passing over the Bussey Bridge near Roslindale, Mass., the bridge gave way. The engine and three cars passed over, but six cars went down some 40 ft., and were completely wrecked. The cars were full of passengers on the way to their work in Boston, and of these 28 were killed and 114 more or less injured. Five of these have since died. The bridge was a deck-bridge, crossing a highway road at an angle at 45°, and was 110 ft. long. The two trusses were built at different times and of different patterns, the latest one having been in place since 1876. It is charged that the bridge was in bad condition, and to substantiate this, a broken hanger has been shown which was evidently cracked for some time before the final failure. Others claim that a car was derailed on or near the bridge, and that the shock of this derailed car threw the trusses from their seats. It is to be noted that the cars were heated by old-fashioned stoves and that two (one account says three) of them caught fire. The fire was, however, quickly put out by a fire-engine from the village close by.

The Massachusetts Railroad Commissioners are now making an examination into the causes of the disaster.

Blast Furnaces in 1856 and in 1886.—The *American Manufacturer* gives a table showing the number of blast furnaces in the United States in 1856 and in 1886, the totals being as follows:

Fuel.	1856.	1886.
Charcoal	416	174
Anthracite	121	124
Bituminous and Coke	43	280
Total	580	578

The *Manufacturer* says: "The totals show that the charcoal furnaces very largely outnumbered the anthracite and bituminous furnaces in 1856, there being 416 of the former, compared with 121 anthracite and only 43 bituminous, while in 1886 the totals had changed to 174 charcoal furnaces, 124 anthracite and 280 bituminous, the charcoal and bituminous furnaces changing places as to number. Another noticeable feature is the fact that there were no more productive furnaces in the country in 1886 than there were in 1856, but of course the production was many times greater.

Taking the states separately, Maine had 1 furnace in 1856 and 1 in 1886; New Hampshire had 5 in the former period, and none in the latter; the same is true of Vermont; Massachusetts had 10, against 8 now; Connecticut 15; against 9 now; New York had 43, against 39; Pennsylvania was far in the lead, and has kept it ever since; Maryland had 30, against 19. Several of the Southern States also had a greater number of furnaces in 1856 than in 1886. Tennessee had 41, against 17; Kentucky 30, against 6; Georgia 7, against 4; South Carolina 4, against none. Twenty-two States made pig-iron in 1856 and twenty-six States and Territories produced it in 1886.

"The production of pig-iron in 1856 was 814,017 tons; in 1886 it was 6,366,688 tons, or near 8 times as much.

"Of the total quantity of pig-iron produced in the United States in 1856 Pennsylvania made over 55 per cent; of the total produced in 1886 she made nearly 52 per cent. Ohio produced more in 1886 than the whole country produced in 1856, and Allegheny County, Pa., will do the same thing this year."

Nail Production in the United States.—The *Iron Age* says: "The American Iron & Steel Association has published the statistics of the production of cut nails for 1886. Aside from the very great increase in the make which the figures show—from 6,696,815 kegs in 1885 to 8,160,973 kegs in 1886—their principal interest lies in the evidence of the great progress which steel has made as the material of which they are made. The change from iron to steel has been uneven, geographically considered. In the great Wheeling District the product consisted of 1,841,402 kegs of steel nails, and only 17,149 kegs of iron nails. With its greatest competitor, the Central Pennsylvania District, the figures are nearly reversed, there having been made only 142,179 kegs of steel nails, and 1,347,303 kegs of iron nails. Yet the year 1886 was really one of preparation, outside of the Wheeling District, and the heavy demand for rails, by making a supply of nail slabs scarce, tended to cut off those works not producing their own steel. Quite a number of plants have been finished in 1886, or are now building, with the object of exclusively or partially supplying the raw material for steel nail manufacture. Among them are one in Massachusetts, one in Virginia, two in Pittsburgh and several in Illinois and Ohio. Besides this, considerable quantities of foreign slabs were bought for works in Pennsylvania and elsewhere, prior to the rise, of which a heavy percentage is being worked up during this first quarter of the current year. There is every prospect, therefore, that the percentage of steel, which was 36 per cent. of the total in 1886, will advance considerably during 1887.

"This movement entails a concentration of manufacture in the hands of fewer and larger producers. It will be readily understood, too, that it brings into closer relations the nail trade, and that leading industry, the rail manufacture. Last year's make of steel nails must have called for at least 150,000 gross tons of slabs. Another point worthy of consideration is the progress of the wire nail. It is estimated that in 1886 the product was not less than 400,000 kegs, which would make the total make of cut and wire nails roughly 8,500,000 kegs, an enormous aggregate. Authorities in the wire trade claim that this year will see the product of that class of nails rush up to 1,000,000 kegs. While this statement will be received with reserve, the fact must be recognized that the contest of the future will be between the steel cut nail and the steel wire nail. It remains to be seen which is the cheaper form, all things considered, the nail plate or the wire."

Bridging the Mississippi.—The report to the Secretary of War on the proposed new bridge at St. Louis is signed by Colonel H. L. Abbott, Major A. Mackenzie, Major A. M. Miller and Captain E. H. Ruffner, U. S. Engineers. From this report the following extracts are taken:

"The importance of a free, unobstructed navigation of the lower Mississippi River is immense. It has been recognized by Congress by large annual appropriations. It alone affords protection against extortionate charges for transportation by corporations. A slight difference in cost of construction in the interest of a single locality should have no weight when considering a question of this national importance. * * *

"The channel is constantly shifting, and a draw properly placed now might be entirely out of place in a few months, making the bridge impassable. Uncertain and costly works of channel regulation are therefore inseparable from a low bridge.

"The drift running out of the Missouri and past St. Louis at every rise would render it impossible, without great danger to life and property, for a boat to control its tow by backing; but this is the only safe mode of passing a draw in a strong current. There being no drift on the upper Mississippi, this difficulty does not affect existing draw-bridges above the mouth of the Missouri. * * *

"The Board has reason to believe that if a drawbridge was built, it is probable that the channel might at times leave the draw-span and thus make the drawbridge impassable.

"The Board calls attention to the fact that an essential feature of the plan of a low bridge is that the channel should be held through the draw-spans. It is not certain that this can be done at all; certainly not without great cost.

"The Board is decidedly of the opinion that a low bridge with a draw in it should not be authorized or allowed below the mouth of the Missouri River. Such a structure would be a serious and grave obstruction to navigation and a direct and oppressive tax upon all river interests. Justice to navigation interests requires that the proposed bridge should be no greater tax upon commerce of the river than is absolutely necessary. Channel spans of 500 ft. clear width, giving a clear headway of not less than 50 ft. at high water, are the least dimensions that should be authorized, and with recent progress in engineering and the introduction of the cantilever principle it is not expecting too much to suggest that spans of even more than 500 ft. may be found to be both practicable and economical.

"The Board desires to emphasize the difference of the Mississippi River above and below the mouth of the Missouri River. Above, it is a quiet river, comparatively free from sediment and drift: the oscillation between high and low water does not exceed about 22 ft. Although low bridges on such a stream are obstructions to navigation, they are not intolerably so. Below the mouth of the Missouri all this is changed. The rise and fall increases to 42 ft. at St. Louis, and over 50 ft. at Cairo; the current doubles in velocity; the volume of sediment is vastly increased; drift frequently runs; the bed is constantly shifting. In a word, the river entirely changes its character, and low bridges must be regarded as an intolerable nuisance to navigation interests.

"The Ohio River which, in its lower course, resembles the lower Mississippi, is protected by a general bridge law forbidding the construction of low bridges, and, in the judgment of the Board, such a law, properly adapted to suit the requirements of the Mississippi below the mouth of the Missouri River, would be useful legislation, in view of the increasing demand for bridges on the lower Mississippi River."

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid...............$3 00
Single copies... 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, MAY, 1887.

THE office of the RAILROAD AND ENGINEERING JOURNAL is now at No. 45 Broadway, New York, having been removed from No. 23 Murray Street on May 1. All communications for the JOURNAL, its proprietor, or its editors should be addressed to No. 45 Broadway, New York.

IT is reported that a number of prominent railroad companies have agreed to unite in a scheme for selecting one automatic coupler for general use. The companies which have joined in the plan will appoint representatives, who will recommend some one coupler, and the companies all agree to adopt whatever coupler is thus recommended. Probably this is the only way that any agreement can ever be reached on this point.

THE discussion of Mr. Metcalf's paper on Steel in the American Society of Civil Engineers, was one of the most extended which has been called out by any paper presented for a long time past. This discussion took a wide range, and served to show the general interest in the question—and also to show how great the differences of opinion are among engineers as to the uses of steel, and how much uncertainty there is with many, as to its true nature and the best methods of dealing with it.

ONE notable feature of the discussion was the great attention paid to the use of steel for guns. Mr. Metcalf's paper dealt with this question, it is true, but gun steel was not the only, nor indeed the chief subject of which he wrote. Nevertheless gun steel was the subject chiefly spoken of in the discussions, and the question of steel for bridges and other structural uses, took up but a small part of the time. That the naval officers who joined in the discussion should treat of guns alone was, of course, to be expected, but the amount of attention paid to them by the engineers was somewhat remarkable.

SOME progress is to be recorded in naval matters during the past month. The contracts for the steel armor-plates for vessels now under construction and for the steel forgings for heavy guns, which have been pending for some months, have been let to the Bethlehem Iron Company. That company was not only the lowest bidder, but it had also made such progress in erecting the necessary plant for handling heavy masses of steel that it was able to promise delivery of both the plates and forgings at an earlier date than any of its competitors. That such heavy plants have not heretofore existed in this country is not be taken as any reflection on the enterprise of our steel-makers; it is simply due to the fact that heretofore the demand for heavy plates and forgings, which has been created abroad by government calls for land and naval armament, has not existed here. It is also to be remembered that a continuance of this demand for military purposes can be relied on in England, France and Germany, while its duration here is very uncertain.

The Navy Department, as noted elsewhere, has issued proposals for several of the new vessels whose construction has been authorized by Congress, and is now awaiting bids from contractors.

The plans for two of the large vessels authorized—an armored cruiser and an armored battle-ship—have been handed in and are under consideration by a mixed board of naval officers and civilian constructors.

All of these things indicate progress, and it is encouraging to note that there is an evident intention on the part of the naval authorities that this progress shall be intelligently directed, and the additions to the Navy shall be of as permanent value as possible.

THE investigation of the Bussey Bridge accident by the Massachusetts Railroad Commissioners has resulted in an elaborate report which is not yet submitted to the Legislature as we go to press. It is said, however, that the Commissioners, after carefully considering the evidence, are of opinion that there was no derailment of the train before it reached the bridge, and no accident or breakage of the train or the bridge which could have accounted for its fall. They believe that the accident was caused by the simple failure of the bridge, which had reached a point where, owing to original structural weakness and long wear, it was no longer able to carry the loads put upon it.

The Massachusetts Commission has always been very careful in its investigations and findings in accident cases, and its decisions have accordingly had mnch weight. That there was much testimony of an uncertain and contradictory character is true, but this is almost always the case in such inquiries, and simply shows that the present one was no exception to the general rule.

NARROW-GAUGE lines continue to diminish rapidly in number. During the past month the Jacksonville, Tampa & Key West Company, in Florida, changed a branch of 30 miles from 3 ft. to standard gauge, and the Dayton & Ironton road, of 167 miles, in Ohio, was changed April 3. The Havana, Rantoul & Eastern, one of the longest narrar-gauge lines in Illinois, has passed into the hands of the Illinois Central Company and is to be changed as soon as arrangements can be made.

At this rate there will be only a few isolated local lines of the narrow-gauge left in the United States, outside of the mountain lines in Colorado and Utah, and it is not im-

probable that these will follow the prevailing movement towards uniform gauge as their business increases.

THE recent agitation of the question of rapid transit in New York City, and the need of additional facilities for the movement of passengers, has developed a new public interest in the matter. So far as public opinion has found expression, it would seem to favor elevated rather than underground lines, although the latter find many advocates. There is a very decided feeling, however, that any grants of new privileges should be very carefully made, and should be entirely independent of existing corporations. At present, it seems probable that nothing will be done this year.

THE article published in another column on " Bridges and Steam Ferries in India," is of interest in showing by inference how railroad practice in that country has almost exactly reversed our own. The first railroads in India were modeled on the English lines and were very solidly and expensively built, but experience has taught Indian engineers that, with the exception of a few important lines of traffic, such roads could not be expected to return interest on their cost, and there has been a gradual reversal of the original methods and a substitution of a cheaper style of road. The old methods still survive to some extent, however, and in the last year or two some very expensive works have been undertaken.

River crossings have always been among the most difficult problems with which engineers in India have had to deal, and there are probably few countries in the world with an equal mileage of railroad which have more large and costly bridges. More than one of these, as the paper referred to claims, could well have been dispensed with, and the capital applied to the building of needed branches and extensions.

The arguments brought forward by the writer, with the exception of those based upon military necessity, will not seem novel in this country, where the steam ferry for the transfer of cars is so frequently used that its employment seems to be a matter of course, and it is only when the traffic becomes heavy enough to warrant it, or where circumstances are especially favorable, that the question of building a bridge is considered at all.

STANDARD RAIL SECTIONS.

THE great diversity in the forms of rail-sections has been a subject of lament by railroad engineers and rail manufacturers for many years past. Various efforts have been made to secure the adoption of standard forms, but thus far without avail. Most young engineers, when first placed in charge of a line of railroad, feel that their careers and their reputations will not be assured unless they first design one or more new forms of rail sections, which they fondly believe and assert are better than any other form ever devised. The present diversity of forms is a consequence, in part, of their ambitious efforts. While this great variety is to be regretted, there can be no doubt that the present and past state of the art is and has been a condition of evolution, and that the forms of sections have been slowly improved, although every change which hss been made has not always been in the direction of progress. It is very obvious, though, that if at any time during the past ten, twenty or thirty years, a standard system of rail-sections had been adopted that their design would now be antiquated. At present, as in the past, general agreement in any forms of sections seems hopeless. Before people will agree they must think alike, but, as error assumes countless forms, our only hope of agreement in this case, as in many others, is from an increase of knowledge which will lead to right

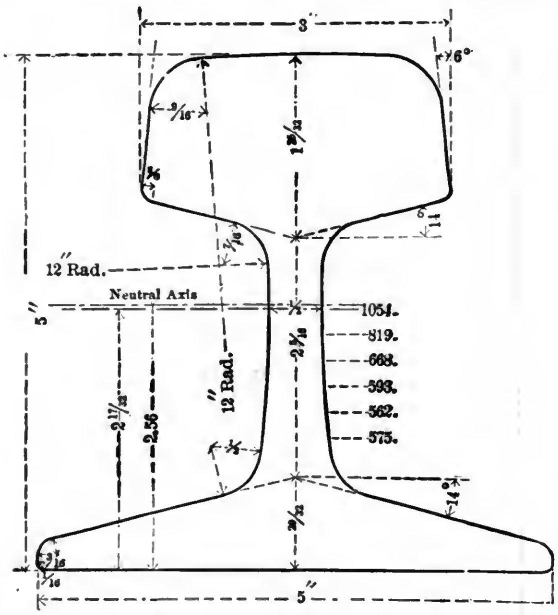


Fig. 1. Proposed 88 lbs.

thinking on this subject. For this reason every able discussion of the subject, like that contained in the paper of Mr. W. F. Mattes, which was read at the Scranton meeting of the Institute of Mining Engineers in February—which we regret we have not room for—must be regarded as a distinct advance towards agreement on some standard form for rails.

The shape of rail proposed by the author of the paper is that shown by fig. 1 which, it will be seen, differs from

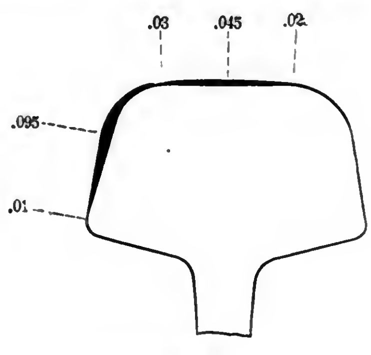


Fig. 2.

rail sections in ordinary use, chiefly in having a wider head in proportion to its weight, and a web which is thicker at the bottom than at the top. The reason given for this increase in the thickness of the web is that it increases the lateral strength and the vertical stiffness of the rail. But do we need more strength in our rails to resist the lateral thrust of the wheels? Do rails bend or break in the web? If they do, it is not generally known. About seventeen years ago the late Baron Von Weber made a series of experiments to determine how

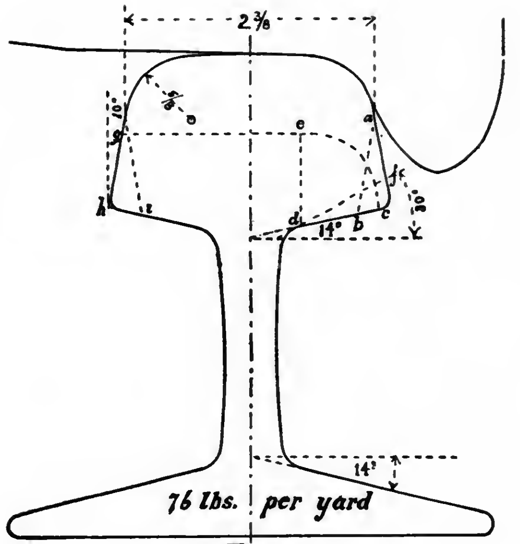


Fig 3

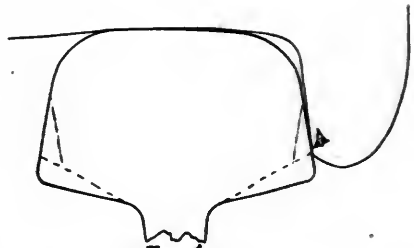


Fig. 4.

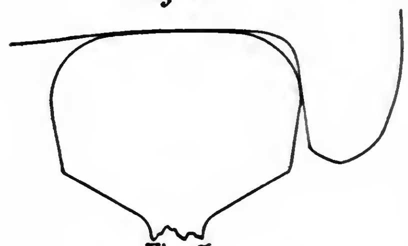


Fig 5.

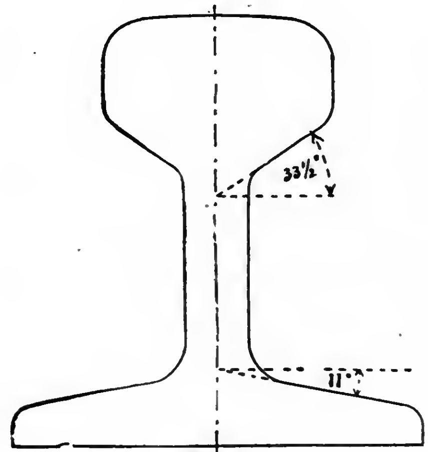


Fig 6.

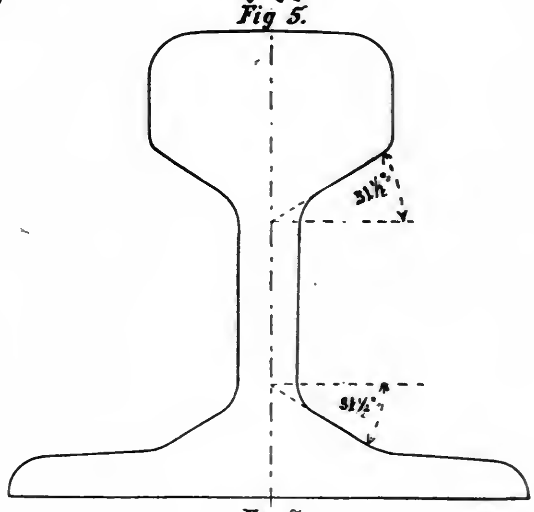


Fig 7.

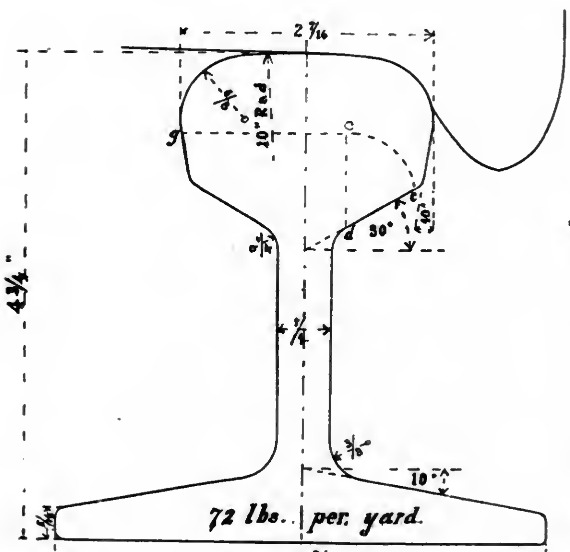


Fig. 8

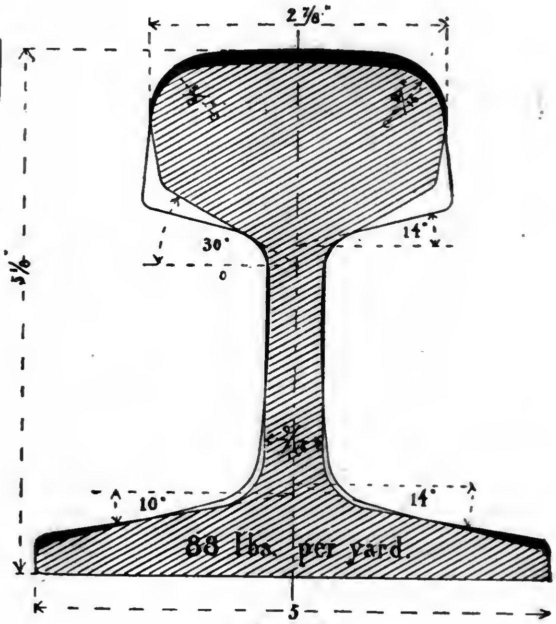


Fig. 9.

thick the webs of rails should be. A report of these experiments was published in *Engineering* in 1870. He planed down the webs of some rails until they were onlv ⅛ in. thick. With this diminished thickness, he found that they had ample vertical strength and stiffness, and their lateral strength was so great that, after spiking them down with double the number of spikes ordinarily used, they were all drawn out by means of a lever attached to the head of the rail, so that the rail could be turned sideways. His conclusion was that webs ⅜ or ½ inch thick were amply strong enough in practice. In fact, on a straight line, there is very little lateral thrust, and on curves the curvature of the rail increases the lateral strength enormously. It would seem, therefore, that to thicken up the lower part of the web adds to its strength when no addition is needed. In fact, to make the lateral strength of the web greater than the resistance of the spikes is useless.

It would seem, too, as if the vertical stiffness would be increased more if the metal which is added to the web were put into the base of the rail. In other words it does not seem that the metal required to thicken up the web is placed "where it will do the most good."

Fig. 3 is a section of the standard 76-lb. rail used on the Lehigh Valley Railroad. This form of rail may be taken as an example of late practice in this country. It will be seen that the sides of the head of this rail slope at an angle of 10° to a vertical line. The reason given for adopting this form is that the rails are worn to this shape by the action of the wheel flanges. This reason is neither satisfactory nor conclusive. The flanges of wheels are worn "square" or "sharp" by the action of the rails, but we do not, therefore, conclude that new flanges should be made square or sharp. There is very little, if any, more reason for making rails of the shape to which they are worn, than there is for making flanges of the shape to which they wear.

In fig. 3, a new wheel-tread is shown on the top of the rail with its flange in contact with the corner of the rail-head. It will be seen that the flange does not touch the side of the head at all. In fig. 4, a worn wheel-tread with a sharp flange is shown on top of the Lehigh Valley rail-head. In this case, it will be seen that the lower edge of the flange touches the side of the rail-head at *A*. Referring to these rails Mr. Mattes says, "wheel-tires that are in good condition will have little effect upon such a head beyond that which is properly due to the rolling load, but worn tires produce abrasion of the side slope that is very noticible on tangents and severe on curves. Fig. 2 shows the wear of some of these rails, which were laid in May, 1884, on a tangent near Pittston. The track there is double, fairly ballasted, and the traffic not particularly heavy. The figures give the wear in decimals of an inch, and the noticeable feature is that the wear is deeper on the side than on the top. Upon the next curve, of about 2°, the excess of side wear was still greater, and upon heavier curves at Mauch Chunk it was decidedly objectionable."

With reference to the mutual action of a flange and rail on each other, as shown in Fig. 3, is concerned, it is difficult to see what good is effected by that part of the rail-head included in the triangle *a b c*, because the flange does not come in contact with this part of the rail at all. On the other hand, it is generally agreed by experienced railroad men that if the lower edge of a flange impinges against the rail, as shown in fig. 4, that the flange is liable to mount the rail. In other words, the flanges which are of the right form *do not* touch the sides of rail-heads shaped like that shown in figs. 1 and 3, whereas flanges which are worn sharp, and are therefore dangerous, do touch the sloping sides. If, instead of sloping outward, the sides of the head sloped inward as indicated by the dotted line *a b*, Fig. 2, then a sharp flange would occupy the relation to the rail shown in fig. 5, and would not touch the side of the head.

It may therefore be inferred that so far as the mutual action of the rails and flanges on each other is concerned, that it would be better to slope the sides of the rail-heads the reverse way from that usually practiced, as indicated by dotted lines *a b* in figs. 3 and 4. If this were done the weight of the rail would be reduced, or the metal included in the triangles *a b c* and *g h i*, fig. 3, could be added to the top of the rail, and the section of metal available for wear would thereby be increased.

It may be said, though, that if the sides of the head are inclined inward, as indicated by the dotted lines *a b* and *g i* in fig. 3, that the bearing surface *d c* of the fish-plates will be diminished to an injurious degree. Before this objection is considered, let us give some examination to the shape of the under side, *d c* of the head.

The first fish-plates that were used were what are called "plain" bars, in distinction from angle-bars, which are now generally adopted. With plain bars it was considered essential that the angle of their top bearing under the head, should be the same as that of the lower bearing on top of the flange, so that the fish-plates or bars would be reversible, and thus avoid the risk of having them put on upside down. At the same time it was essential that the angles of these bearings should be sufficiently obtuse so that the bars could be kept tight by; screwing them up. An obtuse "fishing-angle," on top of the lower flange has, however, the objection, that either the outer edges of the flange must be made very thin, or the middle of greater thickness than is required for strength, or perhaps both, as is the case in the Lehigh Valley rail.

There are two objections to thin edges on the flange: first, they are difficult to roll and liable to crack in rolling, and second, they have very little bearing surface against the spikes, and are therefore liable to cut into the spikes. More thickness in the center of the flange than is essential for strength is a waste of material. These considerations, as stated, led to the adoption of as small a fishing angle on top of the rail flange as it was found practicable to use. The angles have varied from about 10°, with a horizontal line, to 18°, and to prevent the fish-plates from being put on the rails upside down, the upper and lower fishing angles were made alike. That led to making them both as acute as was practicable. When the angle fish-plates were introduced, the necessity for making the top and bottom fishing angles alike no longer existed, but the practice was established and adhered to, and affords another striking illustration of how prone mankind are to adhere to a habit or a precedent after the reason for its continuance has passed away.

If angle fish-plates are used, it is plain that the upper and lower fishing angles need not be alike. It will be clear, too, that if the rail-head shown on fig. 3 was worn away so that its top would conform to the dotted line *g e c*, that the weak point of the rail-head would be on the

line $c\ d$ and that the fishing angle was made 30°, as indicated by the dotted line $d\ f$, that is if the metal is included within the triangle $d\ f\ c$ was entirely removed that the worn rail-head would still have substantially as much strength as it had before this change was made. In other words, the metal included in the triangle $d\ f\ c$ does not add to the strength of the rail-head, nor to the area of metal which is worn away, and consequently, if the fishing angle can be made 30°, this metal, and an equal amount on the opposite side of the rail, may be saved or added to the top where it will be useful in resisting wear.

The question then arises whether a fishing angle of 30° can be used without unduly straining the fish-bolts. Of course if they are unduly strained, they will break, but if they do not break with such an angle, it is evidence that the obtuse angle does no harm.

Fig. 6 represents a form of rail used on the Grand Trunk Railway prior to 1882, the upper fishing angle of which is 33½°. The Chief Engineer of that line has stated that there was no trouble from the breaking of bolts while that form of rail was used. Fig. 7 shows a rail used on the Great Southern & Western Railway of Ireland, the top and bottom fishing angles of which were both 31½°. We have testimony from both of these lines that there was no trouble from the breakage of bolts with fishing angles as great as those represented. On many other European, especially Continental roads, what would here be called very steep fishing angles are used. It therefore seems quite safe to use an angle under the head of 30°. There is also the advantage that with a steep angle, the fish-plates will hold the rails more truly in line. With such angles any inaccuracy of fit of the fish-plates on the rails, permits less lateral deviation of the rails than a smaller angle would.

In fig. 4 the external outline represents the head of the 76-lb. Lehigh Valley rail, and the dotted lines, the suggested changes therefrom. The areas between them show the metal which, if taken away, would not diminish the endurance of the Lehigh Valley rail section. It should be noted that, notwithstanding this reduction, the area which is available for wear, is nearly the same in the reduced section as it was in the original.

The aforegoing consideration, if put into practice, will then lead to a design of rail like that represented by fig. 8. This has a straight web 9-16 in. thick. A bottom flange 5-16 in. thick on the edges, which have flat, vertical surfaces, to give a liberal bearing for the spikes. The fishing angle on top of the flange is 10°, the angle under the head is 30°, with a horizontal line. The head is made $2\frac{7}{16}$ in. wide, measured over the curves of the top corners whose radii are ⅝ in. The Lehigh Valley rail is 3⅜ in. wide at the same point. The sides of the head of the proposed rail slope inward with an angle of 10° to a perpendicular. The bearing surface under the heads for the fish-plates is the same in both rails. Without going into refined calculations with reference to the relative stiffness of the two forms, the fact that metal is taken from near the neutral axis of the one section, where it contributes very little to the stiffness of the rail, and is distributed in the top of the head, and the edges of the flanges of the other section indicates that the one will not be inferior to the other in rigidity. This taken in connection with the fact that the proposed section will weigh only 72 lbs. per yard instead of 76 lbs., a difference of more than 5 per cent., is perhaps sufficient excuse for calling attention to the reasons which led to its design.

Returning now to the rail proposed by Mr. Mattes, it will be seen that he has not escaped from the habit of thinking that the top and bottom fishing angles should be the same. He has made them both 14°. If the bottom one was 10° he could increase the thickness of the edges of the flange for bearing against the spikes, which would distribute the metal nearer the bottom of the rail, which would then add to the stiffness without any increase in the area of this part of the rail section. If the increase in thickness and strength of the lower part of the web is needless, then the metal which has been added to that point could also be put into the flange, which would add still further to the stiffness. If the angle under the head should be increased to 30°, and the sides of the head were sloped inward, with an angle of 10°, instead of outward, the metal which could thus be removed from the lower part and sides of the head could be put on top, where it would add most to the wearing capacity and stiffness of the rail. Fig. 9 shows the modifications of Mr. Mattes' section as proposed above. The parts shaded with parallel lines represent the parts of the rails common to both sections, the black parts, what has been added to Mr. Mattes' section, and the unshaded portions, what has been taken away from it. The results of these changes would be that the superfluous material in the web, where it is not needed, would be put into the edges of the flange where it is of use. The rail would be increased in height about 2½ per cent. with a corresponding addition to its stiffness, and the metal in the top of the head, which is available for wear, would be increased from 15 to 20 per cent.

As stated in the beginning of this article, agreement on standard rail-sections will only be possible, when the reasons for adopting one form of section rather than another are thoroughly understood. To that end Mr. Mattes' paper is a very valuable contribution, and it is with the same object in view that it has been discussed here.

The Locomotive as a Hygrometer.

THE above title will probably lead some readers to inquire—an least mentally—what is a hygrometer? To save them the trouble of looking in the dictionary it may be well to say that Webster defines *Hygrometer* as "an instrument for measuring the degree of moisture in the atmosphere."

An English observer says that the manner in which the waste steam from a traveling locomotive conducts itself after leaving the chimney indicates very accurately the amount of moisture in the air. He says:

"Does the vapor linger in the atmosphere as if undecided whether to disappear or not? then saturation point is not far away. On the other haud, if it is snatched up with avidity, depend upon it it is a dry day with no chance of falling rain. Dwelling within a league of one of our main lines, I can testify of these variations from numerous observations. I have seen, on a hot summer's day, passenger trains rising an incline near our station, and therefore under full stroke of steam, without giving the slightest indication of their motive power, vomiting no smoke at the same time. At another time I have just had time to detect it ere it vanished. At others it has been visible for three or four yards, then for the whole length of the train, and so on, finally stretching, on damp and wet days, a long distance away. I have seen, in the height

of summer, steam hang about considerably, with large patches of blue sky overhead—a curious revelation to me at first. Indeed, this hygrometer is a very delicate informant.

"And some of the daily variations are not less remarkable. Working in a hayfield one day last summer, adjoining the railroad, I was determined not to let the opportunity slip by. Up to 1 o'clock each passing train had given a gloomy appearance, which seemed likely to continue, the sky being overcast, while the hay or grass refused to be made. But, somehow, soon after the sun burst forth, the sky grew clear, and the trains began speedily to prophesy, if it can be called so. Gradually the steam disappeared, the afternoon became exceedingly hot, and never did hay make faster. It was carried in that day; of course there was the same moisture in the air as before. The sun, in raising the temperature of the atmosphere, had made all the difference in giving it greater absorptive powers. A fortnight in the early hay season of last year was declared by this test to be phenomenally dry. Washerwomen and farmers please note when living near a railroad."

This observer's conclusions seem very reasonable, and they could probably be verified by the observations of others. Without doubt some of our readers have noticed something of the same kind; if they have, their observations may be of interest to others, and we would be pleased to hear from them.

NEW PUBLICATIONS.

LEVELING, AND ITS GENERAL APPLICATION; THOMAS HOLLOWAY. London and New York: E. & F. N. Spon, 1887. Octavo, xi + 147 pages. Price, $2.00.

THIS volume, written by a practical English surveyor, is of interest as exhibiting the methods of leveling fieldwork in England. The theory of the subject, including the methods of keeping notes and the adjustment of instruments, is set forth in a clear manner, and does not materially differ from the presentations given in our textbooks on surveying. The practice, however, is different in many particulars. The leveling rod—called a staff—has no target, being universally of the "speaking" kind. The level is generally a "dumpy" with inverting telescope. The following extracts, selected almost at random, will give an idea of the methods recommended by the author:

"For general home use I prefer a 12-in. level, without either compass or short transverse bubble tube; but were I contemplating works of considerable magnitude, or emigration, I should prefer a 14-in. one, having a compass.

"To set up the instrument correctly: Remove the cap from the tripod. Erect the tripod by extending its legs to a convenient distance, and carefully examine it to see that it is quite free from shake, either from want of firm bedding and heading of the wood into the metal, or from looseness of any of the joints or screws. The examination being found in every way satisfactory, press the legs firmly either upon or into the ground, keeping the upper plate as nearly level as it can be kept by the eye, and mount the instrumeut by firmly screwing it on.

"Some surveyors compel the staff-holder to carry an iron shoe to plant the staff upon, but I never yet saw the advantage to be derived from its employment, although I am informed that it is good on loose, sandy soils.

"Some surveyors, when leveling up or down an incline, erect the instrument at some distance to the side of the line of operations, with the view of equalizing the lengths of the sites; this system is to be condemned, because it is more likely to increase error than to diminish it, and because it wastes time.

"Nothing can possibly contribute more to the assistance of an engineer, in the development of a new country, than contour lines; but as it is tedious and costly to define them, in respect of such differences of altitude as would render them of thorough practical utility, they are seldom employed."

Judging from this book, leveling in England seems to be a difficult operation, requiring much practice and great skill to succesfully execute. Even the bench-marks of the ordnance survey seem unreliable, for the author advises surveyers to ignore them "and proceed solely on the more reliable lines of self-dependence." Stadia leveling, now so common here, seems to be unknown in England, although the germs of the method are alluded to under the phrase "leveling aided by the application of the law of perspective," which, however, is merely an explanation of the way of determining horizontal distances by means of stadia lines in the telescope of the level. No statements are made as to the degree of precision attainable or desirable in leveling.

PETROLEUM, ITS PRODUCTION AND USE. By BOVERTON REDWOOD, F. I. C., F. C. S., New York, D. Van Nostrand.

THIS little book is abridged from the Cantor lectures before the Society of Arts, London, and forms another of Van Nostrand's Science Series. As its origin would indicate, it is written in a popular style, and begins with what may be called the geology of petroleum and its chemistry. The second chapter is devoted to a description of the methods of drilling oil wells, and of the appliances used for securing and increasing their product both in this country and in Russia. A description of the methods employed in the United States and elsewhere for transporting petroleum is also given in the second chapter. This is followed in the third with a description of "the processes adopted for the manufacture and distribution of the various commercial products, as well as to the methods employed for ascertaining the quality of these products and their suitability for the purposes to which they are to be applied." The fourth and last chapter is devoted to illumination, with descriptions of various kinds of lamps, wicks, etc., which have been devised and are used for lighting. Probably any one can get more information about the subjects which it discusses from this little book, in a few hours, than he could get from any other source within his reach. It is easy reading, and as interesting as a novel. It is without an index, which is its worst fault.

BOOKS RECEIVED.

SEVENTH ANNUAL REPORT OF THE RAILROAD COMMISSIONERS OF CALIFORNIA; Sacramento, Cal.: State Printing Office.

THE MEIGS ELEVATED RAILROAD.—By JOE. V. MEIGS. Boston: Charles H. Whiting. This pamphlet, or rather book, of 180 pages, contains an illustrated description of the Meigs plan for elevated railroads, with the arguments in favor of it.

REPORT OF THE SECRETARY OF THE NAVY. The report this year is of unusual interest, owing to the active work now in progress on the increase of the Navy.

TECHNICAL EDUCATION IN INDUSTRIAL PURSUITS, WITH SPECIAL REFERENCE TO RAILROAD SERVICE. This is a report made to the President of the Baltimore & Ohio Railroad Company by Dr. W. T. Barnard, Assistant to the President.

FOURTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF KANSAS: 1886. Topeka, Kan.: State Printer.

THE CRANK; Sibley College, Cornell University, Ithaca, N. Y. This is not, as its name might indicate, the organ of the car-coupler inventors, but a monthly magazine of very creditable quality, published by the students of Sibley College, and thus representing the students in Mechanical and Electrical Engineering in Cornell University. Its name is derived from the indispensable mechanical crank, not from the human variety.

CHALLEN'S ENGINEERS' LOG BOOK OF DAILY RUNS FOR THE YEAR; Howard Challen, 150 Nassau street, New York. This book contains a leaf for each week in the year; it is ruled and printed across two pages, giving the month; day of week; average pressure per gauge; hours run; revolutions; vacuum per gauge; piston speed (feet per minute); indicated horse power; initial pressure per indicator; terminal pressure; temperature of hot wells; temperature of heater; water per H. P.; fuel burned; ashes and waste; oil and waste used; defects reported; repairs made and remarks.

OBITUARY.

MR. THOMAS ADAMSON died recently at his residence in Cincinnati, O., aged 65 years. He was General Roadmaster of the Ohio & Mississippi Railway, and had been on that line over 20 years. Mr. Adamson took a prominent part in forming the Roadmasters' Association of America, and was Treasurer of the Association.

MR. JOHN E. PARKE, who died at Downingtown, Pa., April 10, aged 79 years, was one of the oldest railroad contractors in the country. He built part of the old road from Philadelphia to Columbia, and had several contracts on the Georgia Railroad, when the late J. Edgar Thomson was Chief Engineer. Mr. Parke remained in Georgia from 1833 to 1858, when he retired from business and went back to Pennsylvania to live.

MR. SAMUEL HOUSTON, who died of pneumonia at Piedmont, W. Va., April 10, had been for many years in the service of the Baltimore & Ohio Railroad. For some time past he had been Division Master Mechanic in charge of the Piedmont shops. He was 60 years of age.

MR. LEVI D. BRUYN died suddenly at his residence in Long Branch, N. J., April 10. He was born in Ulster County, N. Y., in 1835, and, after learning his profession as a civil engineer, was employed on several New York roads. About 1852, he went to New Jersey and was appointed Chief Engineer of the Raritan & Delaware Bay (afterward the New Jersey Southern) Railroad, and located most of that road. Subsequently he was Chief Engineer and afterward Superintendent of the New Jersey & New York road. For some time past he has been Resident Engineer of the New Jersey Southern and the New York & Long Branch roads.

MR. JAMES ROBERTSON THOMPSON, for 40 years chief owner of the Jersey City Steel Works, died at his resideece in New York, April 18, aged 65 years. He was born in Fulton County, N. Y., but spent most of his early life in Philadelphia. He established the steel works in Jersey City and has been at the head of the concern ever since.

HON. ALEXANDER MITCHELL died in New York, April 19, while on his way from Florida to his home in Milwaukee. He was born in Scotland in 1817 and came to this country in 1839, settling in Milwaukee, where he soon became known as a successful banker, and gradually accumulated a fortune. Of late years he has been best known as President of the Chicago, Milwaukee & St. Paul Company, having held that position since the present company was formed, 18 years ago. Mr. Mitchell served two terms in Congress from the Milwaukee District. He leaves a very large estate.

MR. JOHN LORD HAYES, who died in Cambridge, Mass., April 18, aged 75 years, was a lawyer by training and profession, but engaged in many other enterprises. In 1846. coöperating with others in Portsmouth, N. H., he organized the Katahdin Iron Works Company of Maine, for the manufacture of charcoal iron. He organized and was Secretary of the Mexican, Rio Grande & Pacific Railroad Company, and in 1854 obtained a charter from the Mexican Government which authorized the construction of a road across Mexico.

MR. HORATIO G. BROOKS died suddenly of apoplexy at his residence in Dunkirk, N. Y., April 20, aged 58 years. He was of New England orgin and learned the trade of a machinist in the Boston shops of the Boston & Maine Railroad; he was also employed on that road for some time as fireman and locomotive engineer. He went to the Erie in 1850, in charge of some locomotives from the Hinkley & Drury shops; he remained on the road till 1856, when he went to the Ohio & Mississippi, but four years later went back to the Erie as Master Mechanic of the Western Division. In 1865 he was appointed Superintendent of Motive Power of the whole road. In 1869, Mr. Brooks and his associates leased from the Erie Company its shops at Dunkirk, N. Y., and established the Brooks Locomotive Works, which have since become so well and widely known. The business of the works was gradually extended and built up until it was placed on a solid foundation, and the Brooks locomotive came to be known on railroads all over the country.

During the 17 years since the establishment of the works, Mr. Brooks has remained the active head of the concern, and the reputation which it attained was largely due to his mechanical experience and judgment. He was a very popular man and made friends wherever he went; he had also the friendship and good will of his associates and employés, whose welfare he cared for in many ways. Some years ago he established, in the Brooks Works, a school for the technical instruction of apprentices, which has done much good work.

Contributions.

THE GEODETIC WORK IN THE UNITED STATES.

III. THE UNITED STATES LAKE SURVEY.

BY PROF. J. HOWARD GORE.

CHRONOLOGICALLY, the next work of this character that reached completion was the United States Lake Survey. It was begun in 1841, finished in 1878, and when done it was well done.

The moving cause for this survey was the increasing lake traffic incident to the rapid settlement of the then Northwest, and the absolute necessity for that knowledge of the coast which alone could give to the lake sailors a feeling of security. The ultimate object, then, of this undertaking was to map the coasts of the Great Lakes, showing possible harbors, treacherous shoals and dangerous rocks. An objection may be here raised that this purpose would not bring this work under the head of Geodesy, on the ground that Geodesy pertains to the determination of the size and shape of the earth. But we shall soon see that the Lake Survey is being considered in its proper place if we can subscribe to the definition

given by General Cutts: "Geodesy, in practice, may be described as a system of the most exact land-measurements, extended, in the form of a triangulation, over a large area; controlled in its relation to the meridian by astronomical azimuths; computed by formulæ based on the dimensions of the spheroid; and placed in its true position on the surface of the earth by astronomical latitudes and differences of longitude from an established meridian."

This survey of more than 6,000 miles of coast needed to be checked by a strong chain of triangles, sufficiently near to connect with the secondary triangulation upon which the hydrography rested. This chain included 205 stations, it depended upon 12 bases, was oriented by azimuth observations at 11 stations and fixed in position by latitude determination at 16 points and longitude at 12. From beginning to end, it was directed by 9 different engineer officers, who had the assistance of 40 under officers and 127 civilians in the capacity of observers, computers, recorders, draftsmen and clerks. The published results are: 53 charts, with 110,897 distributed and a quarto volume of 925 pages, containing a report upon the primary triangulation, compiled by General Comstock, and published under the auspices of the Corps of Engineers, U. S. Army, in 1882. The entire cost for field and office work, together with instruments and publications was $3,037,509.

In the measurement of the base-lines in 1843 and 1844, a rope was stretched from two stakes 500 ft. apart, their tops being at the same elevation; upon this were placed, end to end, three well-seasoned wooden rods, each having in its under side a groove, so that it would easily rest upon the rope.

The Mackinac base was measured in 1844, in a manner that was a decided improvement upon the above. The apparatus in this case consisted of four iron bars, each 10 ft. long, resting one by one on a mahogany carriage, a little shorter than the bar, the whole being supported by two tripods. In measuring, the rods were placed level, and contact made by bringing the rear end of the bar so that it would touch a hair suspended from the forward end of the preceding bar, the hair being made vertical by an attached plumb-bob swinging in water—a method used in the Bessel apparatus prior to the employment of a sector to determine the inclination.

A Bache-Würdeman apparatus, 15 ft. in length, was purchased in 1857, and with it the seven bases of the following 20 years were measured. This apparatus, which was a combination of the principles of Colby and Borden with a few improvements, originated in the U. S. Coast Survey, and will be described in an ensuing article.

Without reflecting upon his predecessors, it must be acknowledged that when Colonel Comstock was placed in charge, many improvements in both instruments and methods were introduced. In the Minnesota Point base a middle point was selected, which, with the two ends and an auxiliary station suitably situated, formed three triangles, making it possible to compute the length of each segment from the measured whole. The discrepancies thus found between the values for the two parts were — 0.506 in. and + 0.507 in., while the probable error in the entire line was 0.45 in. in a distance of 3.8 miles. As computed from Keweenaw base, about 240 miles distant, the length was 2.55 in. shorter than was found by measurement.

The Fond du Lac base was also computed from the Keweenaw base through a chain of 320 miles, giving a length only 1.16 in. shorter than the measured value. The discrepancy in this instance was one-fifth the error that might have been expected from the probable errors in the determination of the angles of the intervening triangles.

In the measurement of the Keweenaw base in 1873, the apparatus was protected from the action of the sun by a movable awning. In obtaining the probable error, 0.419 in., there were considered the following sources of error: Ascertaining the length of the tube; determining the inclination; reference to and from the ground; change of the length of the tube and reduction to sea-level arising from the uncertainty in the elevation of the base.

The Sandy Creek base was measured twice in 1874; the difference in the two results was only 0.545 in., and the probable error was 0.21 in. In the preceding measurements a short segment was measured two or more times as a test, but the behavior of the apparatus was such as to warrant the acceptance of a single determination.

There was an intermediate point fixed in the Buffalo base and an additional station taken so as to make it possible to compute the length of each segment. The computed values differed from the measured by — 1.04 in. and + 1.06 in., while the length, computed from Sandy Creek base through a chain of triangles whose axis was 210 miles, differed from that found by measurement by 1.44 in., which was only one-third of what might have been expected from the errors in the connecting triangulation.

The Repsold apparatus arrived in 1876, and with it the three bases of the three following years were measured. In this apparatus there are two bars, one steel and one zinc, fastened together at their middle, but free to expand throughout the rest of their lengths. Their unequal expansion is observed upon scales at both ends, making a metallic thermometer on the Borda principle. The two bars are placed within a tube cylinder, which supports them rigidly and protects them from sudden changes of temperature; being further protected during measurement by a covering of thick felt, with a movable awning of sail cloth over the entire apparatus and observers. The tube is provided with a sector to indicate inclination, and a telescope for aligning. In measuring, two tripods carry the tube, these rest upon foot pins, and their heads have three motions as usual. The microscopes have stands similar to the tube tripods; but instead of simply serving the purpose of a marker, the microscopes have a micrometer, in which the fixed wire is adjusted directly over the zero mark on the steel bar, while the movable wire is made to bisect the nearest graduation on the zinc bar, giving a scale reading. From a large series of scale readings at different authenticated temperatures, the value of the scale in terms of degrees of temperature is found, so that, knowing the coëfficient of expansion, temperature, and temperature of the standard length, the exact distance between the zero marks on the steel bar can be known for each tube, and the sum of the projections of such lengths will give the length of the base. In using this apparatus, every precaution then thought of was observed, even to having platforms upon which the observers stood; the points of support so placed that the weight of the observer would be equally distributed about the microscope stand, making it impossible to have all the weight

on one side, and in this way cause a change in the microscope pointing as the observers changed position.

The Chicago base was the first upon which this apparatus was employed. It was divided into 8 segments, and in the second measurement, the discrepancy of the two were noted; in no instance did this excced three-millionths of the segment. The ends of the base were marked by small agate hemispheres set in brass cylinders which were leaded into the tops of granite blocks set in brick work, the agate being three feet below the surface of the ground. The probable error in measuring was 1 : 1,052,200; as computed from the Fond du Lac base, the discrepancy was 1 : 53,616.

The Sandusky base had two angles in it, thus breaking it into three nearly equal parts. A fifth point was selected so as to give well-shaped triangles, through which each segment was computed from the ascertained distance between the two ends. The computations of the segments gave results differing from the measured values by — 0.048, + 0.015 and + 0.033 ft., while the length, as computed from the Buffalo base, 250 miles distant, gave a difference of 0.127 ft.

The Olney base gave 0.0214 ft. as the probable error, and the measured length differed by 0.199 ft. from the value found by computation from the Chicago base, 200 miles distant.

As we have seen, four different kinds of apparatus have been used during the progress of this survey. The first two were too unreliable to deserve special attention. The other two were constructed upon principles that had strong supporters, each more or less anxious to see his preference take precedence. The salient points of difference were the substitution of the the single tube in Repsold with the metallic thermometer and microscopes for the two tubes of the Bache-Würdeman with the compensating lever and contact level. In the matter of time, the former requires the services of 17 men, and measures an average of 73 tubes a day; the latter needs 25 men and averages 78 lengths per day, working under the same auspices. The average probable error found in using the Repsold apparatus was 0.186 in., the Bache-Würdeman gave 0.365 in.; a value relatively twice as great, though differing absolutely by only 0.18 in.

The standards used prior to 1876 were two yards compared with the Ordnance Survey yard by Col. Clarke; upon his comparisons depend the 15 ft. brass bar which was compared directly with the base apparatus of that length, and the measurements were referred to this brass bar at the temperature of melting ice. When the Repsold apparatus arrived, it was accompanied by a meter, to whose length all subsequent measures were reduced. This was compared with the standard meter in Berlin by Foerster, and afterwards in Paris by Sainte Claire Deville, who gave as the length of the meter, 39.36985 in. at 57° 92 Fah. with .00000585 as the coëfficient of expansion for 1° Fah.

The experience regarding theodolites resembled here that of other parties—beginning with 20 and 24-in. circles, but finding the size a disadvantage in the matter of transportation and nothing in accuracy gained, the large instruments were gradually abandoned and the size reduced to 12 and 14-in. circles having two or three microscopes, and reading to single seconds or to two seconds. Likewise the principle of repetition held sway for a long time, and was not fully discarded until 1872.

Before computing distances and geographical coördinates, a large net of triangles was so adjusted by least squares as to fulfil the usual geometric conditions that the sum of the three angles of a triangle, after being transformed from a spherical to a plane triangle, should be 180°, and that the angles or directions should be the same in every possible combination; and, in addition, that the length of each side should be the same when computed by every available route, or from any accessible base. When the number of conditions permitted, it, the entire chain between and including two bases was adjusted as a single figure; this, in one instance, necessitated the solution of 98 equations.

Prior to 1864, a single pole supported the theodolite when it was necessary to elevate it, surrounded by a platform built upon a separate structure, for the observer. After this time it was found better to have an inner tripod for the instrument, with a surrounding scaffold. In one instance, at Pine Hill, a tree was cut off 104 ft. from the ground for the theodolite support; this was 4 ft. higher than the stump around which the Great Caspar signal was constructed. The highest signal built was 150 ft. high. On short lines, a target, painted white and black, was attached to the center pole, but, when the distance was too great to allow this to be visible, a helioscope was used—in some cases a modification of Gauss's that diminished the size of the pencil of light. The longest line was 101 miles. In all cases the coördinates of the center of the target, referred to the geodetic point, were determined with the utmost precision by plumbing down with a small theodolite. This geodetic point was marked in the same manner as were the termini of the bases, and so described in the record, that each could be found.

When the method of directions was employed, only five were taken in a set, so that each set would not require more than 10 or 15 minutes. If there were more than this number of stations visible, a new initial point would be selected and the remaining directions observed. Sixteen combined results were usually required to be obtained for each angle, but sometimes 24 would be made. Great care was taken to eliminate instrumental errors: eccentricity, by reading all the microscopes; periodic, or accidental errors of graduation, by reading each angle an equal number of times on every 30° or less around the limb; collimation, by reversal. When the probable error of a direction exceeded 0″.3, it was regarded with suspicion and given as little importance as possible in the subsequent computations.

The observations for longitude, latitude and azimuth were made in accordance with the methods that were considered as the most approved. Though, in a few cases, when telegraphic facilities were not available, longitudes were determined by noting the difference in local times between the time of making a flash of powder at one station and the time of observing it at another. The difference between the observed and computed latitude reached 11″.6 as a maximum, and 14″.3 was the maximum difference in longitude. This might naturally be ascribed to a local deflection of the plumb-line, as so many of the stations were on the shore of a deep lake where the difference in the densities of the water on the one side, and the hills on the other would produce a noticeable effect.

Though this work, as was said at first, was prosecuted purely in the interests of topography and hydrography, yet the accuracy with which it was accomplished is such

that the results can be applied to that more extended object of geodesy—the determination of the earth's elements.

The entire triangulation embraced an arc of 11° 47′ 40″, which gave for a degree along the 42d parallel (271,905.3—69.5 *d e*) ft., in which *d* represents the difference between Clarke's value of *e* and whatever value may, in the future, be adopted. It was found that a degree of a meridian in the mean latitude 43° 41′ 10″ is 364,439.3 ft. The former is 66 ft. more than Clarke's spheroid gives, while the latter is 76 ft. less.

The survey, from beginning to end, passed through many stages in its development; not being wedded to any particular method, each was discarded as soon as a better one presented itself, until the very best known had become incorporated. For this reason, I know of no work which better illustrates the growth of geodesy during the same period than does this survey, nor a report that contains so much of interest and information as Comstock's Report on the Primary Triangulation.

RIBBED BOILER TUBES.

[By M. Chomienne, Engineer of the forges of L. Arbel, Rive-de-Gier, France.]

In tubular boilers, even the most nearly perfect, such as the locomotive boiler, there is still a considerable loss of heat in consequence of the insufficient absorption of caloric.

This loss of heat takes place notwithstanding the great increase of the heating surface. This fact is explained by the enormous quantity of gas which passes through the tubes without coming in contact with their walls.

The radiating power of gas being almost nothing, it follows that the transmission of heat can only be made by contact. The solution of the problem then is in the increase of the surface of contact.

In his Treatise on Heat, Petiet says:

"The transmission of heat can be increased by another proceeding, which has not been put in practice, but which, in certain cases, might be very efficacious. We have seen that, for the transmission of heat through a plate, it is necessary to distinguish the absorption by one of the surfaces, the emission by the other and the conduction through the thickness of the metal; under ordinary circumstances the quantity of heat which the metal is able to transmit is much greater than that which it has to transmit. It follows from this that, if, instead of using plates made in different ways, we should use plates traversed by ribs or bars projecting a certain distance into the two fluids, gaseous and liquid, one of which is to impart heat to the other, in thus increasing the extent of surface in contact with the two fluids we would largely increase the effect produced."

M. Ledieu says, in his work on marine boilers:

"Tubes of small diameter, like those used in boilers, have the advantage of presenting, with the same total cross area, a much greater heating surface, but they do not absorb as much heat as their total extent and the high conducting power of the metal would make us suppose.

"The gases which enter the tubes run in parallel lines to the outlet; those parts of the gas which are in contact with the surface of the tube are well cooled, but, as they form always the exterior part of the gaseous stream, they constitute a surface or wrapper with very little conducting power for the heat of the gas which is in the central part of the tube, and finally the total mass reaches the chimney without parting with a sufficient quantity of its heat."

This explanation makes it clear why, in a locomotive, tubes of 4 meters (157½ in.) in length produce almost as much steam, other circumstances being equal, as tubes of 6 meters (236¼ in.). This shows very clearly the necessity of obtaining the heat which exists in the center of the tube, and it is this which has led M. J. Serve, of Givors (Rhone), to seek for an increase in the surfaces of contact.

He has reached this end by substituting for the ordinary smooth tube, a tube carrying inside longitudinal ribs, and to this he has given the name of ribbed or finned tube (*tube à ailerons*). He has thus been able to utilize a much greater proportion of the heat of the gases, as we shall show later.

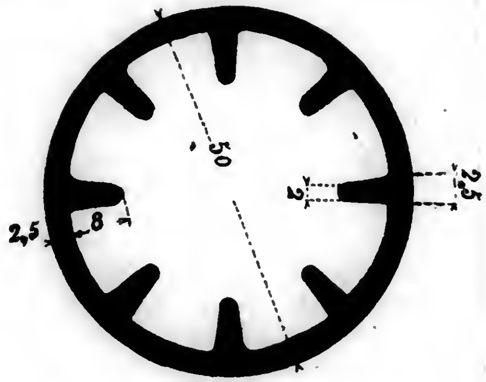


Fig. 1.

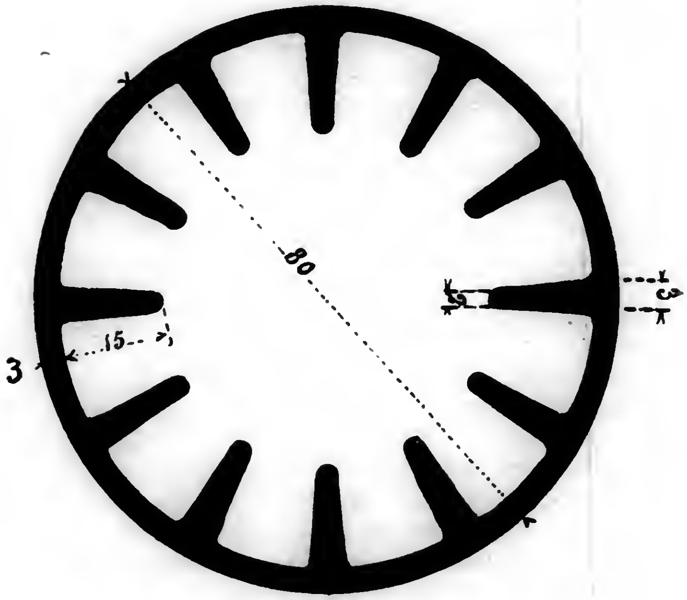


Fig. 2.

The conducting power of the metal transmits immediately to the surface of the tube the heat from the concentric layers in the same tube. It follows that the power of vaporization is increased in very large proportion. The quantity of heat absorbed (we speak only of that which would otherwise be lost) is proportional to the number of ribs and their projection into the tube. The number of ribs arranged regularly around the tube may be 8 in tubes of 50 millimeters (2 in.) diameter or less, and 10 in tubes of greater diameter; their projection into the interior of the tube from 8 to 15 millimeters ($\frac{3}{16}$ to $\frac{9}{16}$ in.) and their thickness from 2 to 3 millimeters ($\frac{1}{12}$ to ⅛ in.). The accompanying cuts, figs. 1 and 2, show two specimen tubes, one of about 2 in. and one of 3⅛ in. diam-

eter. The dimensions given on the cuts are in millimeters.

Under these conditions the manufacture of the tubes will present no difficulty, and the price will be only slightly greater than that of the ordinary smooth tubes (La Société Industrielle et Commerciale des Metaux has already delivered a number to the inventor, and is negotiating with him for the exclusive right to manufacture them).

We can also add that these tubes can be cleaned out as easily as the ordinary tubes by means of the tube-brush.

It will also be possible in case of wear in the end near the fire-box to piece out these tubes with an ordinary tube of the same diameter, without sensibly diminishing the useful effect.

Certain experiments were made by M. Bounardel in the tubular boilers of his steamboat, *Le Bourdon*, plying on the Rhone between Lyons and St. Louis. The tubes used in this case were of 100 millimeters ($3\frac{15}{16}$ in.) diameter outside and 3.5 millimeters ($\frac{1}{8}$ in.) in thickness. The tubes have 8 ribs having 13 millimeters projection, 3.5 thick at the base and 2.5 at the point. (Some of the details of this experiment are omitted as not necessary to a comprehension of the results.)

The boiler was first used with new tubes of the ordinary smooth kind, of copper. Put in service, it vaporized 6.930 kilogrammes of water to the kilogramme of fuel used. The smooth tubes were then replaced by ribbed tubes of the new system and the boiler vaporized 9.338 kilogrammes of water to the kilogramme of fuel—the fuel used being of the same kind and taken from the same lot as in the first trial.

In this case the saving was 35 per cent., but it may be observed that in this boiler the heating surface of the tubes was only $6\frac{1}{2}$ times that of the fire-box, while in locomotives it is 8, 10 or even 12 times as great. From the time the boiler was started up it was easy to see that the economy would be considerable. In fact, in working with the smooth tubes, the sheet-iron base of the smoke-stack burned paper held against it, while with ribbed tubes the paper was uninjured.

In the second trial made in the boilers of the steamboat *Le Bourdon*, one voyage was made going and returning with each of the systems of tubes.

With the smooth tubes the gases of combustion escaped into the smoke-stack at a mean temperature of 360° Centigrade (680° Fahrenheit) measured by a Shaeffer & Budemberg pyrometer, and sometimes reached a temperature of 450° Cent. (842° Fahr.). A ball of lead introduced in an iron cage into the smoke-box melted quickly.

With the ribbed tubes the mean temperature of the escaping gases was 240° Cent. (464° Fahr.) and the lead ball did not begin to melt, which shows that the temperature never rose to the point at which lead melts (330° Cent.).

The fuel consumed in the voyage with the ordinary tubes was 45.000 kilogrammes; with the ribbed tubes, 34,150; showing a saving of 10,850 kilogrammes, or 24 per cent.

It must be remembered that, in a steamboat voyage, as with a locomotive, the factors making up the resistance are numerous and are not often the same. The surest means of realizing the economy secured by the ribbed tubes is to take the temperature of the gases at their entry into the smoke-box; in this way no error is possible.

The tubes used in boilers by the Compagnie Générale de Navigation were of so large a diameter (100 millimeters or nearly 4 in.) that they could hardly be available for the complete utilization by the ribs of the heat produced in the fire-box. With so large a diameter it was difficult to give the ribs sufficient projection to enable them to draw out the heat from the center of the tube. There was in the use of these large tubes what may be called an injurious or useless space, the ribs having too little projection.

The tubes of marine boilers, on the other hand, vary from 70 to 85 millimeters ($2\frac{3}{4}$ to $3\frac{1}{3}$ in.) diameter, and locomotive tubes have not more than 50 millimeters (2 in.). In these the ribs can easily be made with sufficient projection to reduce the useless space to the smallest possible limits, and with these a closer approach can be made to a theoretically perfect utilization of the heat.

Experiments made by M. Serve with apparatus made for the purpose and so arranged that heat could be transmitted only through the ribs, the wall of the tube between the ribs being carefully isolated, still showed very favorable results in favor of the ribbed tube.

The experiments made by Graham and Petiet show that the efficacy of the heating surface of tubes decreases very rapidly as they approach the smoke-box, and show, consequently, the uselessness of long tubes.

Only a very great increase of heating surface will make it possible to absorb the heat of gases at a comparatively low temperature. The following calculations show that this increase can only be obtained by ribbed tubes, without any other change in boilers. In the table below the heating surface is calculated on the exterior diameter of the tubes, while the section for the passage of the gases is calculated on the interior diameter. The thickness of the tubes is taken at 2 millimeters in each case and their length at 4 meters; the interval between each tube, whatever the diameter, remains the same, being taken at 20 millimeters.

PLAIN TUBES.

Diameter.		No. of tubes.	Total surface of tubes.	Interior section of tubes.
Exterior.	Interior.			
Millimeters.	Millimeters.		Sq. meters.	Square meters.
50	46	180	113	0.2989
40	36	245	123	0.2491
30	26	353	133	0.1870
RIBBED TUBES.				
50	46	180	228	0.2629

These comparisons show that, with smooth tubes, if we replace 180 tubes of 50 millimeters diameter by 353 of 30 diameter (occupying the same surface as the preceding) we only gain 20 square meters of heating surface, while we lose on the other hand 0.11 square meter of section out of 0.30, or more than a third.

By changing plain tubes for ribbed tubes we double the heating surface and lose only 0.025 square meter of section, or about one-fifteenth.

These figures require no comment and show the great superiority of the ribbed tubes.

In conclusion, it is claimed that, with the ribbed tubes, there will be a more complete utilization of the heat and more rapid steaming. In locomotives, consequently, larger blast nozzles can be used and a freer exhaust allowed,

reducing the back-pressure. As it will not be necessary to drive the fire and hasten the disengagement of steam, there will be less trouble from wet steam. The gases of combustion being drawn through the tubes at lower speed, there will be less drawing of cinders into the tubes, and less cleaning will be required. The gases will reach the smoke-box at a lower temperature.

The ribs will increase the strength of the tubes, and all support in the center can be dispensed with ; this support or bracing is a frequent cause of wear. As the tubes can be made shorter, the effects of expansion and compression will be less felt.

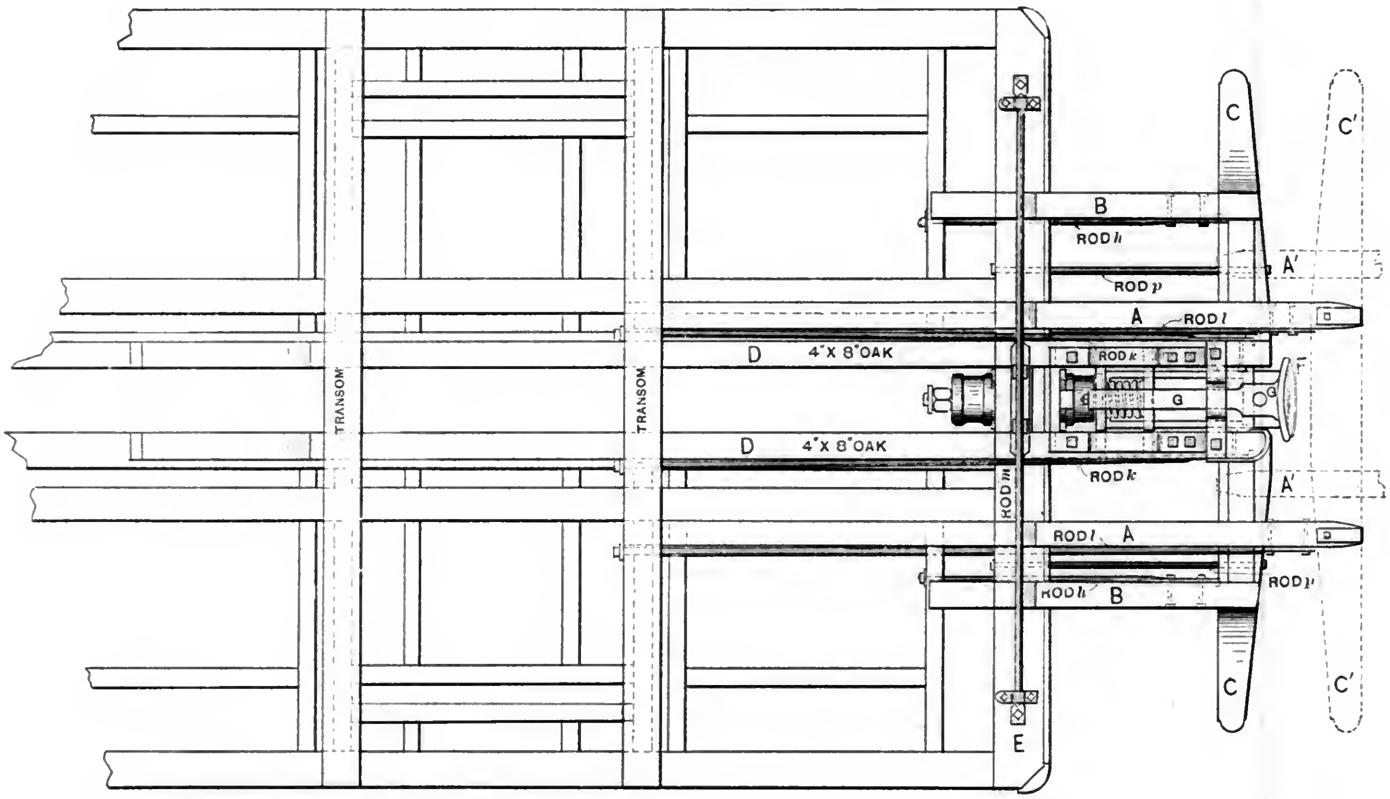
The use of these tubes in marine boilers will diminish the quantity of coal which it is necessary to carry for a voyage, thus increasing the cargo space.

In short, the economy resulting from the use of these tubes will be considerable, in all the applications which may be made of them.

BLACKSTONE'S CAR-PLATFORM AND COUPLING.

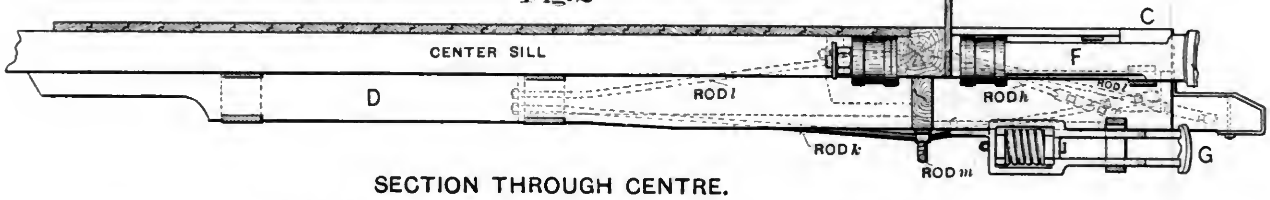
IN an article in the February number of the JOURNAL, on "Heating Cars," attention was called to the fact that in collision the floors of one car usually mounts above that of the other, and the upper car then crushes through the side of the lower one. As the side has very little strength to resist the momentum of the train under these conditions, a slight concussion will cause a serious accident. If the floor timbers of the cars could be kept in line, that is, if the one car could be prevented from raising up above the other, then the whole strength of the longitudinal sills would resist the force of the collision. Some rough diagrams were published with the article referred to, showing how the "horn timbers," which are used in connection with the Blackstone platform, keep the floors of adjoining cars in line with each other. In order to show the construction of this platform more perfectly, the engravings herewith have been made from a drawing for which we are indebted to Mr. Wm. Wilson, Superintendent of Machinery of the Chicago & Alton Railroad.

Fig. 1



INVERTED PLAN.

Fig. 2



SECTION THROUGH CENTRE.

THE BLACKSTONE PLATFORM AND COUPLER FOR PASSENGER-CARS.

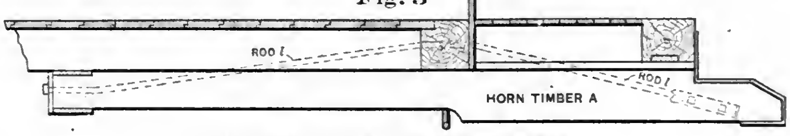
The engravings will require but little explanation. As will be seen, their cars are equipped with two draw-bars to couple with others of a different height from those used on the Chicago & Alton Railroad. The feature, though, to which especial attention was called in the February number of the JOURNAL, was the "horn timbers" *A A*, which are bolted below the sills of the car and extend back to the transom or bolster. These timbers are strengthened with truss-rods *l l*, which can be made of any required strength. The relative position of the horn

timbers A' A' of the adjoining car is shown by dotted lines in fig. 1.

These horn timbers could be used with almost any kind of self-coupler.

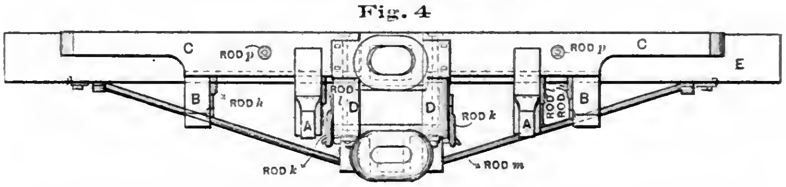
A common impression prevails that Miller platforms are an effectual preventative of telescoping. Many accidents have shown that such is not the case. The Miller platform has very little, if any more, capacity to resist concussion if the cars are not kept in line with each other than the old-fashioned car frames had. The only thing which prevents cars with Miller platforms from mounting on top of each other in collisions is the draw-hook, and this is usually so insecurely fastened that it has comparatively little strength. The "horn timbers" which Mr. Blackstone has devised can be made with any amount of strength, and, it is believed, would do as much to prevent telescoping as the Miller platform has or will. Probably a good many more lives will be sacrificed before the value of Mr. Blackstone's device will be generally recognized. It would not require very great prescience to prophesy that one or more horrible accidents will occur in the not very remote future, in which a good many lives will be sacrificed and which will cause inexpressible suffering; all of which might be prevented by the adoption of the simple device illustrated in the engravings, and which any company is now at liberty to use.

Fig. 3



SECTIONAL VIEW SHOWING HORN TIMBER.

Fig. 4



END ELEVATION.

A New System of Heating Railway Carriages.

(From *Engineering*.)

THE efficient and economic heating of railway carriages in northern climates has long been a vexed question, and many inventors have endeavored to solve it; but the success which has hitherto attended their efforts has in most instances, been of a qualified character. It is satisfactory to know, however, that there is now a prospect of the object aimed at being attained in a thoroughly successful manner. In this case the inventor is Mr. William Foulis, M. Inst. C. E., the Manager-in-Chief to the Glasgow Corporation as Commissioners. That gentleman has devoted much attention during the past year or two to the practical utilization of coal gas as a heating agent, and more especially in devising various ingenious forms of water-heaters of almost instantaneous action. His newest invention involves a further application of the same principles as are turned to account in his water heaters for domestic and other purposes.

In applying his skill to the heating of railway carriages Mr. Foulis takes advantage of the fact that large numbers of them are already fitted with various forms of gas lamps for supplying light; and his aim has been to bring the heat that is developed in the roof of the carriage while the gas is alight down to the floor of the compartment, so as thereby to keep the feet of the passengers comfortably warm, and the whole atmosphere of the compartment at an agreeable temperature. He uses water as the medium for transmitting the heat of the gas flame from the one place to the other. A boiler is placed in the roof of the carriage over the flame of the gas lamp. It is of very simple construction, and the principle on which the heater works is that the heat from the flame comes into contact with the boiler at the point where the water is hottest and leaves it where it is coldest. From this boiler there descend two pipes about ¼ in. in diameter, which are connected to two annular tubes placed underneath the carriage seat. The course which the two pipes take is down through the wooden partition separating the contiguous compartments. Hot water circulates through these pipes and annular tubes, and it returns to the boiler after having given off its heat. The reversal of the current is accomplished by allowing the hot water from the boiler to ascend in a tube a few inches in length, on the top of which there is a small valve. Having passed up this tube, and being unable to return to the boiler, the hot water is made to circulate downward through the pipes. The annular tubes already referred to are about 3½ in. in diameter, and about 8 in. long. They are laid at an angle under the seat, the upper end being raised as far as practicable. The pipe which conveys the hot water is connected to the top of these tubes, and that which carries the return current is connected with the bottom of the same.

Owing to the fact that the tube is placed at an angle and that it is heated, an induced current of air is made to pass through it; and as the air enters the tube at the cold end and leaves it at the hot end, it absorbs the maximum amount of heat from the water. The air flows from these tubes or heaters in a constant stream at a temperature of from 80° to 90°. It has been found that the ordinary size of gas flame is quite sufficient to do the heating of a compartment, though the consumption of gas is less than one cubic foot per hour, and even during the coldest days of winter.

We may mention that the carriage used is a composite one of four compartments, the property of the Glasgow & Southwestern Railway Company. The internal construction of the carriage was entirely rearranged under the superintendence of Mr. Foulis. During the past two months or so numerous experimental runs have been made with this carriage as part of a regular passenger train, several of them being to and from Carlisle. On one or two occasions the patentee has been accompanied by Mr. Smillie, Locomotive Engineer, and other leading officials of the Glasgow & Southwestern Railway Company; and in all cases they have expressed themselves as highly satisfied with the results achieved by Mr. Foulis. The present writer had the pleasure of joining in one of the runs from Kilmarnock to Carlisle and back when the weather was wintry in the extreme, all the hills for many miles being covered with snow. Inside the carriage the temperature was most agreeable, and in marked contrast to the outside. A thermometer hung in the compartment, in which there were only three persons, never fell below 52°, and the extent of the range was only 2°. On other occasions the temperature ranged from 56° to 60°.

Of course, in carriages heated on the Foulis system the gas must be constantly burning—by day as well as by night; but if heating for the comfort of the passengers is to be done it matters not though the heat is obtained from a luminous flame, providing that it is comparatively inexpensive. In this case it is remarkably economical, while as soon as darkness sets in the gas flame does double duty, providing both heat and light. So far as can be seen at present, it must be unhesitatingly declared that Mr. Foulis has made a most important invention; and much credit is due to the directors of the Glasgow & Southwestern Railway Company for giving him facilities to enable him to bring it to its present perfect stage.

CLOUD'S METHOD OF FASTENING STEEL TIRES.

THE engravings represent a method for fastening steel tires on car-wheels, which has recently been patented by Mr. John W. Cloud, Superintendent of Machinery of the New York, Lake Erie & Western Railroad.

It consists of a plate, fig. 3, with notched or serrated edges, which is inserted between the rim of the wheel-center and tire before the tire is shrunk on, and is firmly clamped between them by the contraction of the tire. This plate is made broader than the contact surfaces of the tire and wheel-center, so that the projections on the edges can be bent over, as shown in figs. 1 and 2. The metal strip then performs the double function of preventing the tire from slipping laterally on the wheel-center, and of preventing it from moving radially away from it when fractured.

This plan provides a very simple and cheap method of securing tires to the wheels. Mr. Cloud's address is Buffalo, N. Y.

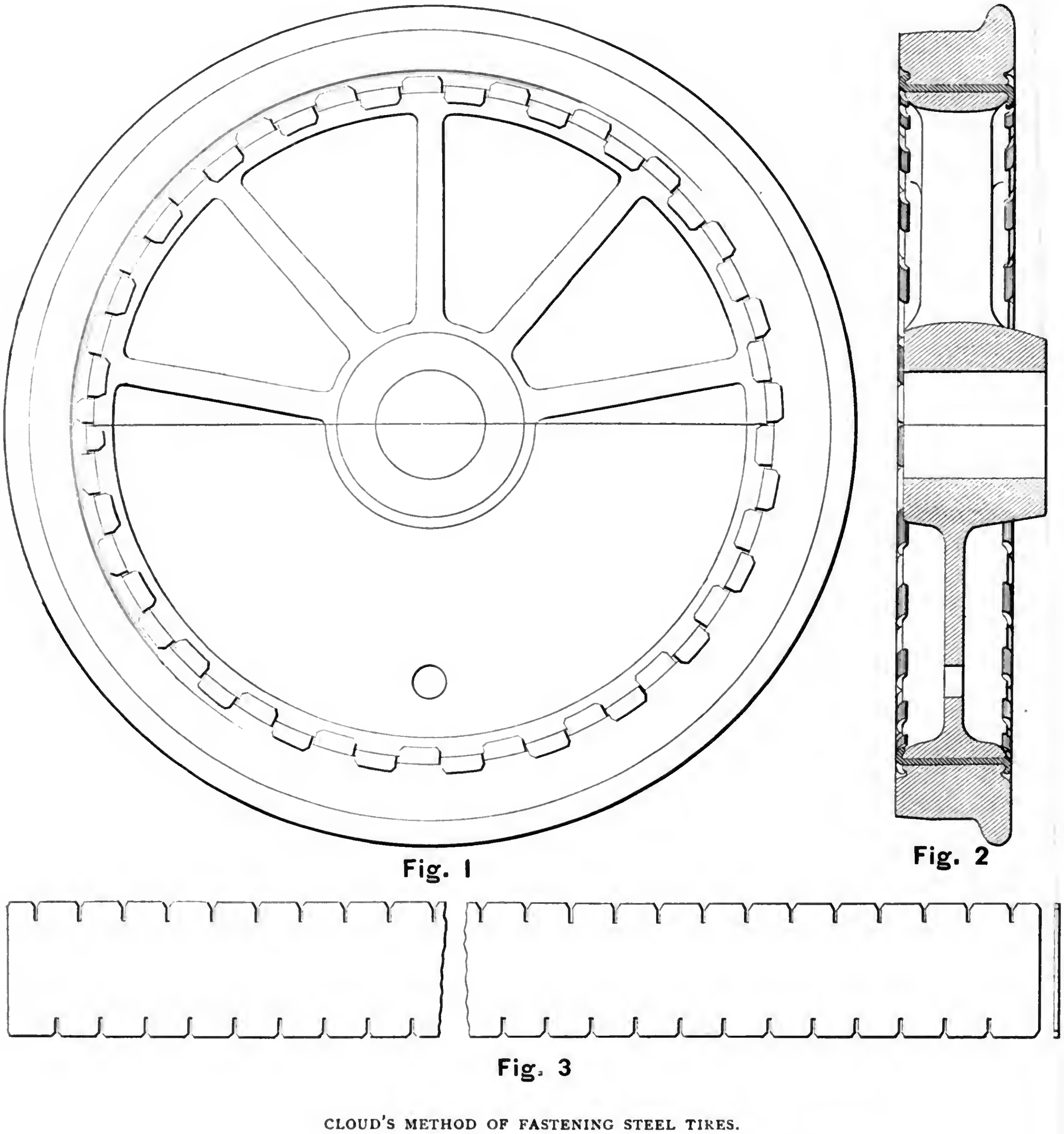


Fig. 1 Fig. 2

Fig. 3

CLOUD'S METHOD OF FASTENING STEEL TIRES.

Painting Signals in France.

The *Revue Générale des Chemins de Fer* of recent date, says that as the result of numerous trials, begun four years ago in its shops at Ermont, the Northern Railroad Company has just issued rules intended to secure fixed colors and durability in the painting of its signals:

"The different colors used are red, white, black, green, yellow and violet, which should be mixed in the liquid composed of oil, essence, dryer and varnish in fixed proportions, by weight (which it is not necessary to repeat here, especially as the formulæ for the liquid and the colors are not given).

"To paint with one coat, and to cover with a coat of varnish the different signals, the following materials are employed:

"1. Distant Signals: 110 grammes red paint (mixed), 65 grammes white paint, 30 grammes black paint and 50 grammes varnish.

"2. Stop Signal: 60 grammes red paint, 135 grammes white paint, 35 grammes black paint and 55 grammes varnish.

"3. Round Cautionary Signals: 65 grammes green paint, 65 grammes white paint, 30 grammes black paint and 35 grammes varnish.

"4. Junction Signal: 40 grammes green paint, 145 grammes white paint and 55 grammes varnish.

"5. Direction Signal: 50 grammes violet paint, 220 grammes white paint, 15 grammes black paint and 75 grammes varnish.

"6. Switch Signal: 25 grammes green paint and 10 grammes varnish.

"7. Large Semaphore Arm: 75 grammes red paint, 65 grammes white paint and 30 grammes varnish.

"8 Small Semaphore Arm: 35 grammes yellow paint and 20 grammes varnish."

TERRACE PARK STATION, BUFFALO, N. Y.

THE two full-page engravings, with this number of The JOURNAL, represent the front and rear elevations and plan of a new station, which is now in progress for the New York Central & Hudson River Railroad in Buffalo, N. Y. The main building is 27 × 139 ft., with an entrance vestibule 17 × 17 ft. The waiting room is 19 × 65 ft. The platform sheds extend about 150 ft. on either side of the building and uncovered platform 700 or 800 ft. beyond. The level of Upper Terrace Street is above the track, and the station is approached by a bridge across the track, which enters the second story of the tower.

The material is a local stone, brick and terra cotta.

The building was designed by R. H. Robertson and A. D. Manning, Associated Architects, of New York City.

Bids for Steel Gun-Forgings and Armor-Plates.

A BRIEF note was made last month of the opening of bids for steel gun-forgings and armor-plates. The Secretary of the Navy has issued the following list of the prices offered:

PROPOSALS FOR STEEL GUN-FORGINGS.

Kind of forging.	Calculated tons.	Bethlehem Iron Co. Price p. ton.	Cambria Iron Co. Price p. ton.	Midvale Steel Co. Price p. ton.
Tubes and jackets for 6-in. breech-loading rifle	146 418	$672.00	$800	$885
Tubes and jackets for 8-in. breech-loading rifle	31.804	716.80	700	1,008
Tubes and jackets for 10-in. breech-loading rifle	426.888	761.60	650	1,232
Tubes and jackets for 12-in. breech-loading rifle	59.470	806.40	750	1,232
Hoops for 6-in. and 8-in. breech-loading rifle	140.474	672.00	800	885
Hoops for 10-in breech-loading rifle.	330.024	761.60	650	1,232
Hoops for 12-in. breech-loading rifle	49.796	761.60	750	1,232
Trunnion-bands	15.292	672.00	800	1,680
Plugs and mushrooms for all calibers	20.864	672.00	650	885
Total price		$902,230.79	$851.513	1,397,240

PROPOSALS FOR STEEL ARMOR-PLATES.

Kind of material.	Estimated tons	Bethlehem Iron Co. Price per ton.	Cleveland Rolling Mill Co. Price per ton.
Side armor for *Puritan*	734.7	$510	$600
Side armor for *Amphitrite* and class	1,066.8	510	600
Turrets and pilot houses for 4 monitors	835.8	575	600
Smoke-pices and ventilators for 4 monitors	266.3	575	600
Armor for breastworks for 2 armored vessels	680.0	575	600
Armor for turrets, conning towers and ammunition tubes for 2 armored vessels	485.0	575	600
Part of side armor for 2 armored vessels.	364.0	500	600
" " "	468.0	575	600
" " "	272.0	600	600
" " "	196.0	600	600
Rolled plates, protective deck armor and gun shields	1,135.0	490	600
Turret and side armor-bolts and steel accessories	181.0	650	600
Small armor bolts, steel	6.0	650	600
Tubing and washers, wrought-iron	12.0	180	600
Total price		$3,610,707	$4,021,560

The contract for both armor-plates and gun-steel was formally awarded to the Bethlehem Iron Company, April 14. The Secretary of the Navy makes the following statement in explanation of the award: "The Bethlehem Iron Company is the only bidder for the whole contract. The theory of the advertisement was that the Government wanted the lowest price for the whole work (paying more or less for one or the other being immaterial, so long as the entire job is obtained at the lowest total price), the total sum for the whole job being the material thing. With this view the advertisement was framed so as to obtain the largest range of bidding, allowing a person to bid for either or for both; but the total sum which the whole should cost the Government being the matter alone to be considered. The two lowest separate bids for the two classes being that of the Cambria Iron Company for the gun steel and the Cleveland Rolling Mill Company for the armor-plate amount to $4,873,073. That of the Bethlehem Iron Company for the same classes amounts to $4,512,938. They are the lowest bidders for the work by the sum of $360,135. Since the bidding has taken place the Bethlehem Company has offered to reduce the prices on the gun-steel, so as to make that company the lowest bidder for each of the separate classes. This may be done under the circumstances, although I should not permit it if I did not consider them, on other grounds, entitled to the award."

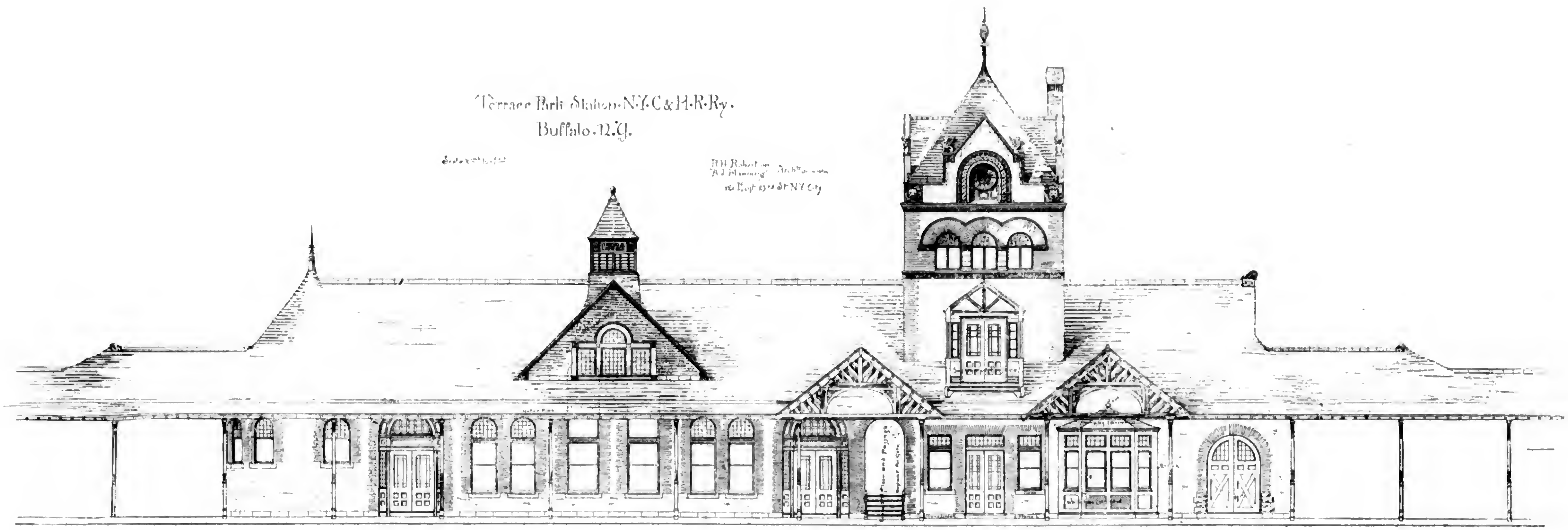
The New War-Ships.

IN Washington, early in April, the designs presented for the two new armored ships authorized the act of August 3, 1886, were opened by the Secretary of the Navy. One of these vessels was to be an armored cruiser, the other a battle-ship, and the general features of each type were to be as follows:

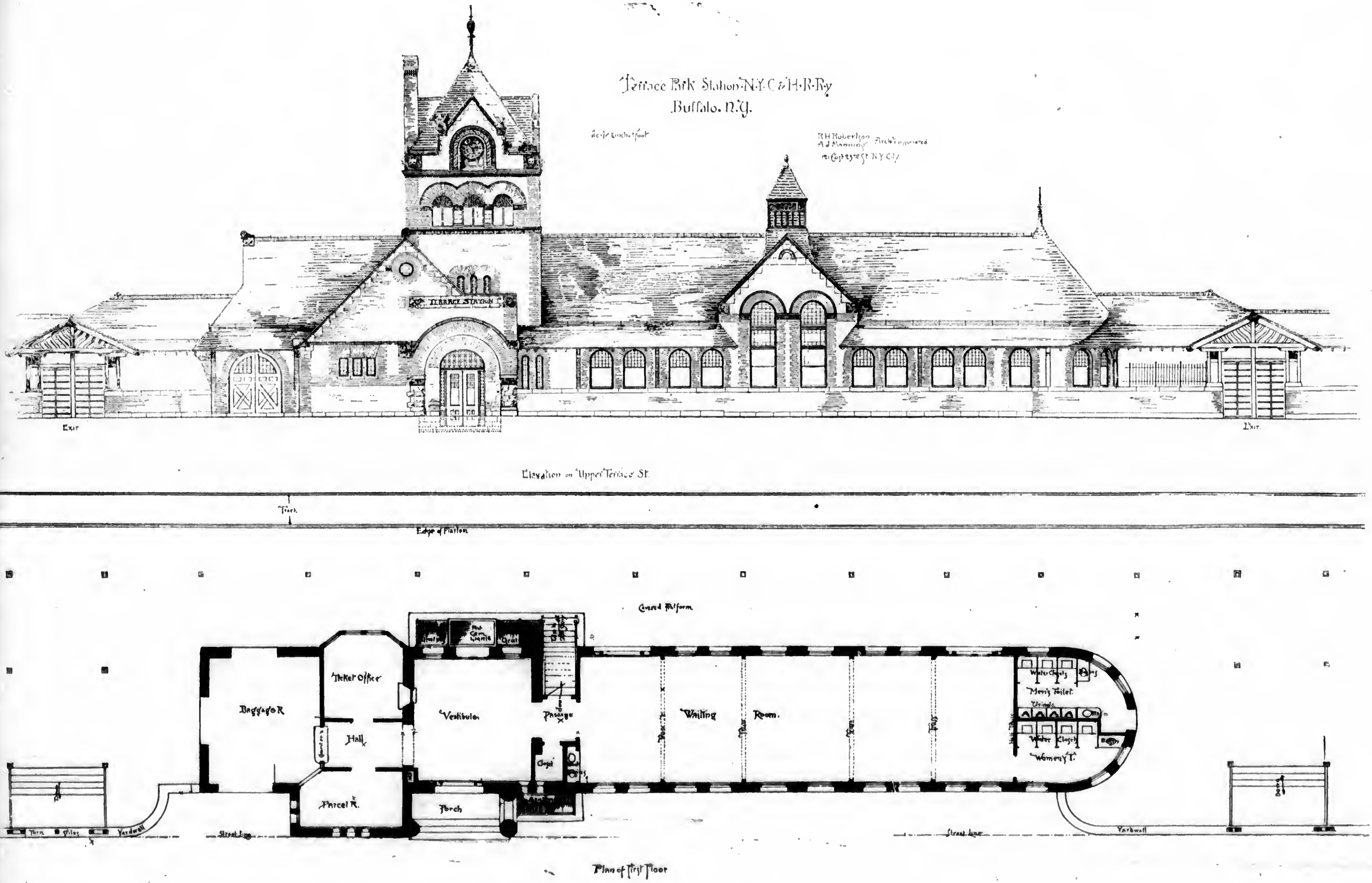
The armored cruiser was to have a double-bottomed steel hull, unsheathed and divided into numerous water-tight compartments, fitted with a powerful pumping apparatus, and finished with a perfect drainage and ventilation system throughout. She was to be fitted with a ram-bow and was to have a steel-armored deck which would run the whole length of the ship and cover the boilers, engines and magazines. Two-thirds full sail power was required on two or three masts, each with a protected top, carrying one or more machine or rapid-fire guns.

The main battery was to have four 10-in. guns, each weighing 26½ tons, and six 6-in. guns each weighing 5 tons. The secondary battery was to be composed of four 6-pounder, four 3-pounder, and two 1-pounder Hotchkiss rapid-fire guns, four 47-millimeters and four 37-millimeters Hotchkiss revolving cannon, and four Gatling guns. The vessel was to be equipped with a torpedo and search-light outfit, and the guns were to be so arranged as to obtain for bow and stern fire the greatest horizontal and vertical command consistent with other essential conditions. The 10-in. guns were to load in at least two positions, and were to be served and handled by power,

Terrace Park Station · N.Y. C & H.R. Ry.
Buffalo. N.Y.



Elevation on Track Side


Terrace Park Station N.Y.C. & H.R.Ry
Buffalo. N.Y.
R.H. Robertson
A.J. Manning
Archts. associated
TERRACE STATION
Exit
Exit
Elevation on Upper Terrace St.
Track
Edge of Platform
Covered Platform
Baggage R.
Ticket Office
Hall
Parcel R.
Vestibule
Porch
Passage
Closet
Waiting Room.
Water Closets
Men's Toilet
Urinals
Water Closets
Women's T.
Street Line
Yardwall
Plan of First Floor

and protected by at least 10½ in. of steel armor, properly backed, while the 6-in. guns were to be efficiently shielded.

The motive machinery was to be below the armored deck and well covered from hostile fire, and the ship was to be driven by twin screws. When fully equipped and with all weights on board, excluding the reserve coal, she was to maintain 17 knots speed per hour over the measured mile. The coal endurance had to be large, the consumption economical, and the distance to be covered at moderate speed as great as practicable. The furnaces were to be arranged to work with forced draught when desired, air for combustion being furnished independently of the ventilating system. Quarters had to be provided for 270 officers and men, with provisions for three months and water for one month. The ship was required to have arrangements for being steered either by power or by hand from several independent positions upon and below the deck. A sufficient number of boats to carry the crew were to be furnished, two of them being second-class torpedo boats and two others steam launches or cutters, each of which was able to mount, shielded, one 3-pounder rapid-fire gun. These conditions were to be fulfilled at a maximum draught of 22 ft. and on a displacement of about 6,000 tons.

The armored battle-ship was to have an unsheathed, double-bottomed, steel hull, divided into numerous water-tight compartments, fitted with a complete and powerful pumping system, and supplied with drainage and ventilation throughout. A ram bow and a steel-armored deck running the whole length of the ship and protecting the boilers, engines and magazines were essential features, as well as one or two military masts, each with a protected top carrying machine-guns. The main battery was to be two 12-in. guns, each weighing 46½ tons, and six 6-in. guns, each weighing 5 tons; and the secondary battery was to consist of four 6-pounder, six 3-pounder, two 1-pounder, all Hotchkiss rapid-fire guns, four 47-millimeter and four 37-millimeter Hotchkiss revolving cannon and four Gatling guns.

All the machinery was to be below the armored deck, well covered from hostile fire, and the ship was to be driven by twin screws. When fully equipped and with all her weights on board, not including the reserve coal, she was to maintain a speed of at least 17 knots per hour over the measured mile. Quarters were to be provided for 270 officers and men, with provisions for three months and water for one month, and the ship was to be capable of being steered either by steam or hydraulic power, or by hand from several independent positions.

Ten designs were received, five from the United States, three from England, one from France and one from New Zealand. These designs were as follows:

1. Chief Constructor T. D. Williams, U. S. N., for the Bureau of Construction, submitted a design for the armored cruiser, the principal dimensions being as follows: Length between perpendiculars, 310 ft.; extreme breadth, 54 ft.; draught of water above base line, 21 ft. 6 in.; displacement, 6,600 tons; speed, 17 knots; coal capacity, 800 tons. The four 10-in. guns are carried in turrets, the six 6-in. guns are mounted on center-pivot carriages, the 10-in. guns and three of the 6-in. guns having a fire both ahead and abeam, while the 13 rapid-fire guns have practically an all-around range. The armor belt is 17 in. thick and 6 ft. deep, being above the water-line when at her greatest draught. The armor on the turrets and breastworks is steel, 10½ in. thick, and that on the pilot house is reduced to 10 in. Ten boats are carried, two being second-class torpedo boats. The vessel bark-rigged, with a sail area of about 7,000 square feet.

In the armored battle-ship the principal dimensions are: Length over all, 318 ft.; length between perpendiculars, 300 ft.; length on load line, 310 ft.; breadth extreme, 58 ft.; displacements in tons, 6,600; draught of water, forward, 21 ft.; draught of water, aft, 23 ft.; speed, 17 knots; capacity of coal bunkers, 800 tons; armament, two 12-in. breechloading rifles in barbettes, those forward having an arc of fire of 300°; two 10-in. breechloading rifles in barbettes aft, having an arc of fire of 280°. Two 6-in. breechloading rifles on central-pivot carriages, with segmental shields, an arc of fire of 180° from direct ahead to direct astern. The two 12-in. and two 10-in. rifles, with one 6-in. rifle, can all be concentrated on an object within 22 ft. from the side of the hull. The secondary battery is as given above. The armor on hull is, in thickness, 12 in.; around barbettes, 12 in.

The boats are 10 in number, two being second-class torpedo boats. There is no sail used, but a single mast will be fitted with two military tops and a derrick for handling boats.

2. Constructor S. H. Pook, U. S. N., presented a design for an armored cruiser of the central-box casemate type.

3. Lieutenant W. I. Chambers, U. S. N., submitted a design for the armored cruiser, in which the 10-in. guns are grouped in pairs in barbette turrets on the middle line of the vessel, each pair having unobstructed arcs of fire of 280 degrees, and mounted at a height of 24½ ft. above water. There are also six 6-in. rifles, two of which are on the spar deck, and have a fire ahead, astern and abeam, through arcs of 180 degrees, the remaining four being mounted on the gun-deck so as to fire two ahead, two astern and two abeam through arcs of 135 degrees. On the gun deck are mounted eight 6-pounder rapid-firing guns, with arcs of 140 degrees, so arranged as to be easily transported to fire all eight from the same broadside. At the extremities on the gun deck are four 47-millimeters revolving cannon in towers which give them nearly 180 degrees arc of fire. Above the spar deck is a spacious bridge extending from the forward conning tower to amidships, where it exte ds from side to side. At the ends of this bridge, amidships, are 3-pounder rapid-firing guns so arranged as to enable all four to be fired ahead, astern and abeam. Two Gatlings and two 1-pounder boat guns are also mounted on this bridge. The side armor is 11 in. thick and the barbette armor 10½ in.

4. Captain L. Tonns, of New York, presented a design of novel character for the cruiser; it was to be lined both inside and outside the skin with wood.

5. Mr. F. L. Norton, of Washington, designer of the Norton lifeboat, presented plans which, though incomplete in military features, offer some novel suggestions as to the construction of hull and armored citadel.

6. The Thames Iron Shipbuilding Company, of London, England, offered designs for both vessels, similar to others built for several foreign countries.

7. The Barrow Shipbuilding Company, of Barrow-in-Furness, England, Mr. John, designer, submitted designs for both ships, the armored cruiser having the 10-in. guns mounted in seperate box-shaped, armored casemates on a covered gun deck, so arranged as to fire two ahead, two astern and two abeam. The battle-ship has the two 12-in. guns mounted *en echelon* on separate turn-tables in a central armored citadel, the armor of which extends from the gun to the spar deck only.

8. Mr. Watt, Birkenhead, England, presented a design for a battle ship on the central-citadel. battery plan.

9. M. Grandjean, St. Nazaire, France, submitted plans for the cruiser, similar in character to several vessels built by the French Government.

10. Captain M. S. Clayton, Auckland, New Zealand, sent a drawing, intended to embody some new ideas. This was, however, a rough draft only and incomplete.

The various designs will be submitted to a board which will consider them and report to the Secretary of the Navy.

New Ships for the British Navy.

(From *Engineering*.)

It has already been stated that no important new ships are to be laid down during the coming financial year, although, as will be presently shown, an exceptionally large number of vessels will be completed and added to the fleet during that period. The following is the programme of new work the Admiralty proposes: Two 20-knot steel-bottomed protected cruisers, at Chatham; three 19¾-knot copper-bottomed protected cruisers, two by contract and one at Portsmouth; one composite sloop (*Buzzard*), six composite gunboats (improved *Rattlers*) and one *Grass-*

hopper class. Another vessel of the *Buzzard* class, the *Daphne*, has already been commenced at Sheerness, although she was not included in former estimates.

With regard to the gunboats and sloops referred to, we are informed that a careful inquiry into the composition of our squadrons abroad has made it clear that too large a proportion of our naval strength is absorbed by small vessels which, however well adapted for police purposes in time of peace or for operation in shoal water, would be of little value for the protection of our commerce on the high seas. All the vessels above referred to will have, we are told, a speed equal to, if not in excess of, any of their class elsewhere, and will therefore be a match for anything of like displacement which they might encounter.

The two 20-knot steel cruisers are the most noteworthy vessels on the programme for next year. The following are the chief particulars as given by the Admiralty statement:

Length, 265 ft.; breadth, 41 ft.; displacement, 2,800 tons; speed on measured mile, with 400 tons of coal, and fully equipped, 20 knots; ocean speed, 17 to 18 knots; radius of action at 10-knot speed, 8,000 knots. The vessels will have a protective steel deck extending from stem to stern, and sheltering the boilers, magazines, steering gear, etc. Vertical (inverted cylinder) triple-expansion engines are to be fitted, special arrangements of armored coamings being built for the protection of the cylinders. Above the protective steel deck the space will be minutely subdivided, coal bunkers, cofferdams, etc., being built as is usual in vessels of the protective class. A double bottom on the cellular principle, adapted for water ballast, will be fitted. The armament will include six 6-in. B. L. R. guns on center-pivot mountings, nine 6-pounder rapid-firing guns, machine guns, six torpedo tubes (all under cover). The bow will be strengthened for ramming in the usual manner. In all respects the vessels will be made suitable for independent sea service, and for being driven at high speed in rough water. They will have only fore-and-aft steadying sails.

The three copper sheathed 19¾-knot cruisers will be like the vessel just described, except that it has been decided to vary them in the following particulars:

To wood-sheathe and copper the bottoms, so as to make the vessels capable of remaining afloat for long periods without serious fouling and consequent loss of speed, and to adopt horizontal engines, placed entirely below the protective deck. These changes involve an increase in displacement and a slight decrease in maximum speed, which are accepted in view of the special services for which the vessels are intended. In armament protection, and all other qualities, the conditions are the same in these as in the steel-bottomed ships

Turning from this very modest programme of new work for the coming year, we find that it is hoped the following vessels will be completed during the coming year and added to the effective list. The list contains ten armored ships, viz.; the *Rodney*, the *Howe* and the *Benbow*, of the *Admiral* class, the *Warspite* and *Hero*, and five contract-built belted cruisers. The protected ships will be the *Severn* and the *Thames*. There will be seven torpedo cruisers, six of the *Archer* class, and the *Fearless*. There will also be three torpedo gunboats of the *Rattlesnake* class, and finally three composite sloops of the *Buzzard* and *Rattler* class. This makes a total of 25 vessels in all. In addition to these, we are told, the *Camperdown* and *Forth* will be nearly finished, and the *Anson* will be approaching completion.

With regard to other ships, the *Immortalité* and *Aurora* will be far advanced. The former is to have £100,585 spent on her next year, after which there will remain the sum of £28,328 to complete; the grand total cost of ship and armament being estimated at £302,902. This vessel is an armor-plated cruiser of 5,000 tons, now building at Chatham. The *Aurora* is a similar ship, and will be in about the same stage of completion at the end of the year. The *Renown* and the *Sanspareil* are to be delivered in October of next year, and the two big ships *Trafalgar* and *Nile* (armor-plated turret ships) remain the chief cause of further liability.

To sum up, out of 37 ships building or incomplete it is expected that 26 will be finished by the end of next March, leaving only nine out of the programme for 1885. There will be in addition two other ships not belonging to that programme, to be thereafter finished. * * * *

The question should be asked, why some important vessels are not to be laid down to carry on the work now so rapidly being completed?

Two possible answers to this question occur to us. Either the Admiralty is afraid to ask for the money, or else the constructive department is unable to advise what type of ship is to take the place of the existing first-class battle-ship. The former solution to the problem is one very possible, and strictly in accordance with precedent; although Lord George Hamilton has on occasions shown a sturdiness of purpose that is somewhat rare amongst First Lords. The alternative proposition would open up quite a new feature in naval administration, and we must say that Mr. White has never displayed any notable diffidence as to his professional abilities. There is, however, a third point of view from which the possibilities of the situation may be surveyed. The constructive department may be quite convinced as to the course which they would recommend, but the naval element in the management of affairs may be quite as satisfied that their views are unsound. Such a state of affairs would lead to a dead-lock which only the supreme authority of the Board could overcome, and that authority, as we know, has already been invoked in the case of of the *Nile* and *Trafalgar*. It will perhaps not be rash to say that had the Constructive Department had their own way we should now have large vessels without side armor on the stocks, battle-ships of the Italian type, but of improved design, and we certainly should not be building the *Trafalgar* and *Nile*. * * *

Another subject dealt with in the present estimates is the depreciation of the fleet, and the following, subject to certain necessary restrictions, is set down in Lord George Hamilton's statement as a reasonable scale on which to fix the annual depreciation for the different classes of vessels:

1. On armored, protected, and partially protected iron or steel vessels, for 22 years from date of completion, 4 per cent.

2. On corvettes, sloops, torpedo cruisers, gun vessels, gunboats, troop-ships, and other vessels, for 15 years, 6 per cent.

3. On torpedo boats, steam launches, etc., for 11 years, 9 per cent.

4. On small vessels, tugs, and yard craft, for 18 years, 5 per cent.

5. On guard, receiving, training, and harbor vessels, for 22 years, 4 per cent.

The Camperdown; A New British Armor-Clad Ship.

THE following description from the London *Times* of a new armor clad ship, which has just been completed and made its trial trip, will probably interest many readers in this country at the present time. Her keel was laid down December 18, 1882, and she was launched November 22, 1885, having thus taken three years to build. She belongs to the *Admiral* class of battle ships, which comprise the *Camperdown*, *Collingwood*, *Benbow*, *Anson*, *Howe* and *Rodney*, the whole of which, with the exception of the *Anson* have made successful trials of their machinery. She measures 330 ft. between perpendiculars, 68 ft. 6 in. in extreme breadth, and 26 ft. 2 in. in depth of hold, her mean draught being 26 ft. 9 in., and her displacement 10,000 tons. She is protected amidships by a water-line belt 150 ft. long, 18 in. thick, 7 ft. 6 in. deep, of which 2 ft. 6 in. are intended to be above water when fully equipped; the whole forming, with athwartship bulkheads at the ends, a central citadel for the protection of the vital parts of the ship. The *Camperdown* will carry four 13½-in. 67-ton breech-loaders in two barbettes placed forward and aft, and covered by 14 in. sloping compound armor; and six 6-in. 5-ton breechloaders under the spar deck. She will be manned by a complement of 430 officers and men. The engines and machinery have been manufactured and fitted on board by Messrs. Maudslay, Sons & Field, of London. They consist of two sets of three-cylinder compound in-

verted engines, having two low-pressure cylinders placed together. Each set of engines has one high-pressure cylinder 52 in. in diameter, and two low-pressure cylinders 74 in. in diameter, the stroke being 45 in. The cylinder linings are of Whitworth's fluid compressed steel. The crank shafts, which are made of steel and hollow, are interchangeable, the cranks being placed at an angle of 120 degrees with each other, while centrifugal lubricators are fitted to the crank pins. The surface condensers, together with the air-pumps and hot wells, are made of gun-metal, and the condensers are constructed so as to be worked as common condensers if required. The condensers contain 11,550 brass tubes, having an external diameter of ¾ in., with a cooling surface of 17,000 sq. ft. The cold water is circulated through the main condensers by centrifugal pumps, each driven by a pair of inverted engines having a stroke of 15 in., the diameter of the cylinders being 12 in. and that of the fans 4 ft. These pumps are also arranged for pumping water out of the ship in case of accident, provision being made for a direct suction of the water from the bilge instead of its having to pass through the condensers. Each set of engines has two air pumps, 30 in. in diameter, worked by wrought-iron beams by means of levers from the cylinder cross-heads .The bilge pumps are also worked by these beams. The boilers are 12 in number, and are placed in four separate compartments forward of the engine-rooms. The boilers are 12 ft. 4 in. wide, 14 ft. 1 in. high, and 9 ft. 11 in. long, having in all 36 furnaces, 3 ft. 2 in. in diameter and 7 ft. long. They are fitted with 3,432 tubes, 2¼ in. in diameter and 7 ft. long, and possess a collective area of fire-grate of 800 sq. ft. The tube plates and combustion chambers are made of the best Yorkshire iron, and the shells of Siemens-Marten steel. The safety valves are of the latest approved type, with spiral springs of square steel, and loaded to 90 lbs. per square inch. The stop valves are placed horizontally and are self-acting. As is now customary, the stokeholds are arranged for working with forced draught when the engines are required to exert their full power, and air-wells are fitted at all the exits. For the purpose of maintaining the air pressure, eight fans, 5 ft. in diameter, are provided, worked by small horizontal engines. Two are located in each boiler room, while means are provided for shutting each one entirely off to prevent the escape of air should the engine break down. Escape ladders and doors have been fitted to the boiler-rooms where possible, the doors flying open immedialely they are released, so as to give those in the stokehold a chance of making good their escape should an accident happen when the boiler room is closed up and under forced draft. In addition to the auxiliary engines already mentioned, there are on board four fan engines with fans 4 ft. 6 in. in diameter, for ventilating the magazines and other parts of the ship.

During the trial under natural draft her immersion was 22 ft. 3 in. forward and 24 ft. 5 in. aft. The machinery worked without giving any trouble to any one concerned from first to last, the bearings remaining cool throughout. With one exception every half-hourly observation showed that the engines were indicating more than 8,000 H. P., and, consequently, in excess of the contract. The mean of the six hours' steaming gave a collective power of 8,605,95, while the ship, as tested by four runs on the measured mile at an early part of the trial, and when the engines were not exerting their greatest power, realized an average speed of 16.3 knots. The reading of the patent log showed that the ship had traveled 112¼ knots during the 6½ hours, which gave her a speed of 17.2 knots an hour. The consumption of fuel during the trial was 2.11 lbs. per H. P. per hour, which, under the conditions mentioned, would enable the *Camperdown* to steam over 2,000 knots.

Another trial was made under forced draft, with even more satisfactory results. Previous to beginning the engine trial the ship was tested as to her steering power, with the following results: Circling to starboard, the tiller was put over from amidships to 34 deg. of helm in 15 seconds, the half-circle was completed in 2 min. 10 sec. and the full circle in 4 min. 53 sec., the diameter of the circle being 630 yards. Circling to port the tiller was put over in 11 seconds, the half-circle was performed in 2 min. 20 sec., and the full circle in 4 min. 42 sec., the diameter being in this instance 650 yards. The vessel was perfectly obedient to the helm, no leverage being necessary to keep her in a straight line. The four hours' trial under forced draft, with 2 in. of water pressure in the stokeholds, was then commenced, the ship being taken long runs to sea to obviate the necessity of turning and so throwing increased strains upon the engines.

No incident of any kind occurred during the four hours to detract from the uniform success of the trial. Two runs were afterward made upon the measured mile, the mean showing a speed of 17.144 knots, which was in substantial agreement with the patent log, which registered a travel of 68¼ knots during the four hours and an everage speed of 17.2 knots. During the day the United Telephone Company, of London, experimented with an instrument for communicating between the bridge and the engine-room. The ordinary voice pipe is impracticable in consequence of the noise produced by the machinery, and a committee has been appointed to consider how the difficulty can be surmounted. The telephonic instrument employed enabled the orders to be heard distinctly while the engines were working at their greatest power, and was favorably received by the officers on board.

Mastless Men-of-War.

In a recent lecture on this subject at the Royal United Service Institution, in London, Eng., by Captain Fitzgerald, R. N., the lecturer said that, though he was of opinion that it would be advisable to unrig immediately all the present ironclads, yet he considered that the carrying out of the idea would be more applicable to future designs for cruisers than to the unrigging of the present single-screw corvettes. He maintained that there was no economy in having masts and sails, as these wore out rapidly and did not save coal, as they stopped the ship more in foul winds than they assisted her in fair. He pressed that the present rigged ironclads would be more powerful fighting machines without their spars and rigging that with them, leaving in their lower masts and turning the tops into small machine-gun batteries. The principal arguments for the abolition of spars and sails in men-of-war, but more particularly in ironclads, were that the weight of masts and sails caused increased immersion and occupied valuable space both on deck and below—space which might otherwise be devoted to warlike stores. They masked, more or less, the fire of guns. There was a probability of wreckage from them fouling the screw in action, and lastly, though perhaps the strongest argument of all, was the fact that the retention of masts and sails in men-of-war diverted so much of the attention, the energy, and the resources of both officers and men from the real work of their profession, and from the study of modern naval warfare, and occupied them in drills and exercises as obsolete for fighting purposes as the bow-and-arrow drill of the Saxons. It was said that a ship's company which was smart at drill aloft was sure to be smart in everything else. This might be true in some cases, but even if it were so, it did not furnish any sufficient argument for keeping up sail-drill. The lecturer discussed at length the objections which would be made to the principles he enunciated, and he claimed that whatever risks there might be in his proposals, these risks were such as occurred even in the carrying of gunpowder, and the necessity of change must be recognized. The duty now before the country was, not to build ships to suit the seamen, but to train the seamen to suit ships in which were the useful inventions of modern time and the innovations of modern science.

A Line-Throwing Gun.

An invention possessing considerable importance in connection with naval matters has recently been successfully tried in the Tilbury Docks, London, The invention is the line-throwing gun of Mr. D. R. Dawson, which is designed to discharge a line, and thus establish communication.

between any two given points, which may be the shore and a ship, or they may be two vessels or two objects on land. There are two of the guns, a shoulder gun throwing a line 160 yards in length and a 3½ in. brass gun mounted on a carriage, which will project a line more than a quarter of a mile long. In both cases the gun is loaded from the muzzle, the powder charge being placed in an annular space formed by the bore and a central inner tube running from breech to muzzle. The line is wound in the form of a cop, with a hollow extending its whole length. This cop is placed in a metallic case or shell, and the rear end of the line is drawn from the rear of the shell, threaded through the central tube of the gun, and made fast outside it. The forward end of the line is previously made fast to the case, which is then inserted in the gun. Upon the gun being discharged, the case pays out the line as it proceeds forward, and upon its reaching the object aimed at the line establishes a connection, so that in the case of a ship in distress a rope on board can be made fast to the line and can be hauled ashore or to another vessel. There is no danger of the line being burnt or damaged by the ignited powder because of the center tube and because a special form of gas-check is used. On the occasion in question several rounds were fired from the shoulder gun with 1¾ drams of rifle powder, the line being in each case run out to its full length of 160 yards in a direct course and being afterward hauled in. The ship gun was fired twice with 7½ oz. of powder and 460 yards of line, which was also fully run out. In the second round, at the request of those present, Mr. Dawson laid the gun over one of the jetties at the dock entrance, which was exactly 800 ft. from the firing point. The case crossed the jetty in perfect line, falling into the River Thames beyond at the full range of over a quarter of a mile. There was no question of the success of the experiments, which demonstrated the efficiency of the line-throwing guns and their adaptability to the purposes they are designed to serve. One important feature is that whereas rockets carry their own explosive, which sometimes deteriorates and causes the rocket to fail, the line gun is charged with powder at the moment of use, so that the charge can always be fresh and dry. The shoulder gun is also intended to be used on land in cases of fire for establishing communication for saving life. Messrs. M'Alister and Co., of 21 West India Dock-road, London, are the sole agents for this useful invention.—*London Times.*

Trial of a New Torpedo Gunboat.

(From the *London Times.*)

The *Rattlesnake*, torpedo gunboat, built and engined by Messrs. Laird Brothers at Birkenhead, has just made a contractor's three hours full-power trial of her machinery at Portsmouth, previons to being received by the Admiralty. She is of 450 tons displacement, and is the first of her class. Hence the interest which attaches to her performances under way. The other vessels of the class are the *Spider*, *Grasshopper* and *Sandfly*, the whole of which are being constructed at the Royal dock yards, the *Grasshopper* at Sheerness and the others at Devonport, while the machinery is being made by Messrs. Maudslay, Sons & Field. The *Rattlesnake* is 200 ft. between perpendiculars, with a beam of 23 ft. and a depth of hold of 13 ft. She is built entirely of steel, and is fitted with a half poop and forecastle, and a conning tower with a conning bridge erected over it. In speed she equals the first-class torpedo boats; while, as she stands well out of the water and has good accommodations between decks, in seaworthiness, ability to keep the sea, and comfort for the crew, she is vastly superior. Her offensive power is also greater. In addition to one torpedo tube through the bow and another through the stern in a fore-and-aft line, and one on each broadside forward capable of training through 90 degrees, she will mount a 4-in. 25 cwt. central pivot breechloader, capable of penetrating 8 in, of armor. This will make her a formidable antagonist to all but heavily protected ships of war. The gun will be surrounded by a steel screen attached to the carriage for the defense of the gunner against machine guns and rifle fire. She will also carry 6 three-pounder Hotchkiss quick-firing guns. Above the bridge an electric search light will be fitted. In engining the *Rattlesnake* the paramount object with the contractors has been to reduce all weights to a *minimum* consistent with efficiency. The contract power of the engines is 2,700 collective H. P.; and when it is considered that this enormous force is contained in a snake-like craft of only 450 tons, while the engines of the corvettes of the C class, of 2,380 tons displacement, develop only 2,430 H. P., the character of the problem which the marine engineer has had to grapple will be readily recognized. The boilers are protected at the forward end and at the sides by coal bunkers capable of stowing 90 tons of fuel, while the engines, which are not divided by bulkheads, are protected by extra thick plating on the sides of the vessel. In the design of the machinery advantage has been taken of the experience derived from the performances of the torpedo fleet, and consequently there are various improvements. The propelling machinery consists of two sets of vertical triple-expansion three-crank engines, having cylinders of 18½, 27 and 42 in. diameters respectively, with a stroke of 18 in., and capable of exerting 2,700 H. P. at about 310 revolutions. The total condensing surface of the condensers amounts to 4,000 square feet. The framing of the engines is entirely composed of steel, and this material has also been largely employed in the construction of the machinery throughout. The crank and other shafting has been manufactured of Whitworth special steel, and is hollow throughout. The propellers are made of solid manganese bronze. They are three-bladed, and have a diameter of 6 ft. 6 in., and a pitch of 7 ft. 6 in. The boilers, four in number, are fitted in two stokeholds, which are wholly separate, so that, in consequence of the duplication adopted, there would be a chance of the *Rattlesnake* making good her escape though partly disabled in her machinery. They are of the locomotive type, but a new principle has been introduced of constructing them with wet bottoms, and with large conical-shaped tubes placed between the furnaces. In addition to increasing the heating surface, this plan affords an efficient means of circulating the water in the boilers. The working pressure is 140 lbs. to the square inch, while the heating surface is about 5,000 ft., and the area of fire-grate 122 ft. The stokeholds are fitted with four fans for providing the forced draught, with which the vessel will be exclusively driven. Besides supplying the propelling machinery, Messrs. Laird have fitted on board a dynamo engine for the search light, an air-compressing machine for the torpedo service, and a steering engine (made by Forrester & Co.), which works very powerful gear in the after part of the vessel below the water-line. This gear is capable of being readily converted into hand gear. The same contractors have also fitted the torpedo tubes and gear, the gun mountings, and other work, in compliance with an extra contract intrusted to them by the Admiralty. In addition to the 90 tons of coal already mentioned, the *Rattlesnake* will carry engine-room stores for six months. Two light spars will be carried for signaling purposes. These torpedo-boat catchers or gunboats are both faster and more formidable than anything of the gunboat class yet designed, and are expected to prove an effective check to the operations of torpedo boats in war.

Considerably greater difficulty attaches to the trials of these small craft, in consequence of the lightness in reciprocations, the want of space and the comparative fewness of the men in charge, than to the trial of a full-sized battle-ship. This will serve to explain the causes of the many failures through which they pass before a thoroughly satisfactory success can be recorded. It will consequently create no surprise to learn that the *Rattlesnake* did not achieve the results notified below until various weaknesses had been rectified, and sundry readjustments of the slides and other moving parts had been made. The trial was watched by Mr. Alton and Mr. Maystow on behalf of the Steam Reserve and the dockyard, and by Messrs. Shapcott and Smith of the Controller's Departpartment, the engines being under the charge of Mr.

Bevis, Jr., as representing the contractors. The vessel was brought down to her load draught by means of iron ballast—namely, 6 ft. 9 in. forward and 9 ft. 11 in. aft. After a short preliminary run the *Rattlesnake* proceeded on a three-hours', official, full-power trial, at the end of which the following mean results were attained: Steam in boilers 136 lbs., which was less than the engines could have utilized; vacuum, 25 in; revolutions, 311 (starboard) and 308 (port); mean pressures—starboard, 59 lbs. high, 28 lbs. intermediate, and 13 lbs. low; port, 58 lbs., high, 28 lbs. intermediate, and 11 lbs. low; indicated H. P., 1,424.10 starboard, and 1,294.17 port; thus giving a collective indicated H. P. of 2,718.27, which is slightly beyond the contract. The mean of six runs upon the measured mile gave a speed of 18.779 knots. It remains, however, to be stated that the weather was somewhat boisterous for so small a craft, the wind blowing from tho southwest with a force of over 3, the result being a probable loss of ten revolutions per minute. On the conclusion of the steam trial the steam steering gear was tested, when it was found that the helm could be put hard over from hard over in 20 seconds. The craft behaved very well in spite of the weather. Though the sea broke over her in clouds of spray, and she proved at times somewhat lively, the vibration was confined to the extreme ends, and there can be no doubt that she will provide a fairly steady platform for the gun which she is intended to carry.

A New Spanish War Vessel.

(From *Engineering*.)

UNDER the name of the *Reina Regente*, Messrs. James & George Thomson, Clydebank, have just launched an armored cruiser which they have built to the order of the Spanish Government. The new ship has an armored or protective deck 4¾ in. in thickness, and the armament is to consist of four 24-centimeter Hontorio 21-ton guns, six 12-centimeter Hontorio guns, six 6-pounder guns of the Nordenfelt type, two 37-millimeter Hotchkiss revolving guns, and a dozen other small guns and five torpedo tubes. The builders have also provided for a speed of 20½ knots and for a radius of action of 12,000 knots.

Measuring 330 ft. in length, and built entirely of steel, the *Reina Regente* will have a displacement of about 5,000 tons for ordinary sea-going purposes, but when fully equipped her displacement will amount to 5,600 tons. In addition to the protection provided by the armored deck, she has an excellent means of defence in her extensive and very minute internal sub-division, there being no fewer than 156 water-tight compartments. Of these, 60 are beneath the armored deck, and there are 83 between that deck and the one above it, that is to say, in that part of the ship which is situated "between wind and water." Most of those 83 water-tight compartments are to be used as coal bunkers, so that any shell or shot that may strike the ship along that belt of her exterior is not likely to get beyond the particular bunker which it may possibly penetrate, consequently it will take many shots to disable the ship.

The *Reina Regente* is a twin-screw ship, and she is to be driven by means of two sets of horizontal engines of the triple-expansion type, of an aggregate of about 12,000 indicated horse-power. These engines are to occupy separate water-tight compartments. Steam will be supplied to them by means of four large boilers, which will also occupy separate water-tight compartments. In addition to those boilers there will be two of Messrs. Merryweather & Co.'s boilers intended for raising steam rapidly in cases of emergency. They will be placed at some distance above the water-line, and they will have connection with all the auxiliary engines of the ship. Besides the two sets of main engines for propelling vessels, there will be between forty and fifty other engines, including two starting en-engines, others for working four 14-in. centrifugal pumps (by Messrs. Drysdale & Co., of the Bon-Accord Engine Works, Glasgow), bilge and fire and feed pumps, ten fan-draught engines, two electric light engines, a capstan engine by Harfield, steering engine and boat-hoisting and ash-hoisting engines by Messrs. Muir & Caldwell, Glasgow.

The pumping arrangements of this highly complicated modern war-ship are on a very complete scale. All the 14-in. centrifugal pumps are connected to a main pipe which runs from stem to stern of the ship, and into which there are branches from every compartment, these being so arranged that the compartments are always in immediate connection with the pumps, so that if any of the compartments should become flooded they are immediately pumped out, while if the water attempts, in the shape of a return current, to enter a compartment from its respective pipe, it is at once prevented by means of an automatic valve. By these arrangements it is only necessary for the engineer to keep his pumps in action, and any water which may happen to get into any compartment will be pumped out without the slightest attention. Before leaving the pumping arrangements we ought to mention that the vessel has a double bottom which extends from side to side and throughout her whole length.

Not only is the *Reina Regente* to have great speed, but she is also to have great rapidity of turning, a point to which much attention has been given in designing this new cruiser, in which there has been fitted a sternway manœuvering rudder designed and patented by Messrs. Thomson & Biles. This type of rudder has given most extraordinary results in the manœuvering of the Russian torpedo boat *Wyborg* and the Spanish torpedo cruiser *El Destructor*, both of which were built and equipped at Clydebank last year. With the improvements that have sincc been made in this rudder, it is confidently believed that the *Reina Regente* will give even still better results.

In this new cruiser the quarters of the officers and the crew will occupy the whole of the main deck—the accommodation to be provided being for 50 of the former and 350 of the latter. Right forward on this deck there are two torpedo tubes; there is also one right aft, and one in each broadside amidships. On the level of the main deck, but projecting beyond the side of the ship, there are four gun towers. The two forward ones fire each 5° across the bow, and to within 30° of right aft; while the the after ones have a similar range round the stern. The remainder of the armament is placed on the upper deck, at the fore end of which there is a platform raised about 4 ft. above the deck, and upon this two of the 21-ton guns will be placed. These guns will fire right ahead, and to within 40° of right aft. The supports of these enormous guns extend right down to the bottom of the vessel, and the ammunition is supplied to them through two heavily armored hoists. The other two 21-ton guns are placed on a similar raised platform aft, and between the two platforms and ranging along both sides of the ship, there are placed the six 12-centimeter guns, two of which fire right forward, two right aft, and the other two having a range of 140°. It is stated that the 21-ton guns could with great ease pierce the armor of any of the armorclads afloat or building, and that the other six guns referred to will be able to pierce the armor of any of the belted cruisers now building for the British Navy. Five of the small guns included in the armament of this cruiser are intended for boat and field service, and other four will be worked from the mast-heads. In all there will be 30 guns in the armament of the *Reina Regente*, which, considering the tonnage of the vessel, must be regarded as very formidable.

Magazine and Repeating Rifles in Europe.

A LECTURE was delivered before the Royal United Service Institution in London, February 25, by Captain Walter H. James, R. E., which is reported at length by the London *Times*:

After referring to the experience with magazine and repeating rifles in previous wars, the lecturer said that he looked forward to the now not far distant day when it would be universally acknowledged in England, as it was on the Continent to a great extent now, that in the proper use of long-range fire, in the adequate training of the men to pour in closely delivered showers of lead at distances up to 1,500 yards or over, lay the path to military

pre-eminence. To this training the magazine rifle formed the proper complement. Armed with it the duly trained soldier possessed the power of multiplying his fire enormously at close range or increasing its volume at long range when necessary. Such weapons required careful training both of the officers and men, frequent practice in their use, careful working out of the problems they gave rise to. As to the increased number of rounds the soldier must have, the men could not carry beyond a certain weight, and that weight must in the future consist very largely of cartridges, the soldier's kit must be carried for him, the regimental supply of ammunition must be increased until each man at the moment of battle could have 100 rounds on him, and at least 40 to 50 in the regimental supply.

The lecturer then referred to the question of magazine rifles in European armies. As usual in all military reforms, in the van of progress stood Germany. Immediately after the war of 1870–71, the experiments which had been begun before it broke out were again taken up, and resulted in the Mauser rifle, known officially as Model 71, from the date at which the pattern was definitely decided on. The Mauser was in the hands of five army corps, and before the summer the whole German army would be furnished with it. The rifle unloaded weighed 10 lbs. 2 oz., its calibre was 0.433, its powder-charge 77 grains, its twist in rifling, one in 50, its muzzle velocity 1,410 ft., and with the new Rothwiler powder 1,571 ft. It could be used either as a single loader or a magazine weapon. The magazine is placed under the barrel and holds eight cartridges; these with one in the elevator and one in the barrel made ten in all. There was nothing particular worth drawing attention to in the construction of the lock or magazine system. To shut off the magazine the breech was opened and a small arm on the left side of the rifle pushed forward; this moved the other end of the cam, of which it formed a part, forward into the underneath portion of the elevator, and thus fixed it so that it did not fall down when the magazine was closed. The Mauser repeater, M. 71-84, fired the same cartridge as the Mauser rifle, M.-71, but latterly experiments had been made with an improved one containing 89½ grains of compressed powder and a steel covered lead bullet. With this cartridge the muzzle velocity was greater, the penetration considerably more, and the trajectory much flattened, especially at close ranges, than the original. In France no definite solution as to the arm to be adopted had as yet been come to. It seemed, however, probable that the arm would be the "Lobell," called after the name of its inventor, a colonel in the French service. Its calibre was 78 mm. or 0.307 in., and the magazine, under the barrel, held eight cartridges. For some years past, however, the French navy had been armed with the Kropatscheck repeater, which differed not materially from the Mauser, except in being a little more complicated. Austria had definitely adopted the Mannlicher rifle. This rifle presented several peculiarities. In the first place the bolt was withdrawn by a straight backward motion, which rendered it much quicker than one in which it was necessary to make a turn, as in most bolt rifles, and hence it could be worked without taking it down from the shoulder. The cartridges were carried packed in tin frames containing five, placed in the case under the bolt-chamber, whence they automatically fell when empty. The cartridges were carried packed in these frames, two being wrapped round with paper, and thus issued to the soldier. The frames weighed 385 grains each—*i.e.*, roughly the weight of a bullet, and cost less than a halfpenny to manufacture. When these cases were placed in the rifle—*e.g.*, when arranged for magazine action, the rifle could not be fired as a single loader, although there was no reason why more than one round should be fired. The cartridge used was the same as that employed for the Werndl rifle, the weapon hitherto in use in the Austro-Hungarian army. Experiments were, however, being made with an improved cartridge giving a higher initial velocity. The weight of the rifle was 9 lbs. 8½ oz., its bullet weighed 371 grains, the rifle calibre was 0.433, its powder-charge 77 grains, and its muzzle velocity 1,437 ft. In Italy experiments had been conducted for some years past, and it had been finally determined to alter the Vetterli rifle (an ordinary form of bolt gun) in accordance with the system known as the Vitali. A magazine was fixed in a central position under the bolt-chamber, in front of the trigger-guard, in which four cartridges packed in a special cardboard box were pushed from above. It, like the Mannlicher, could not be used as a single loader when the cartridges were placed in the magazine. This change was avowedly only a temporary expedient pending the introduction of an improved and probably smaller bore rifle. It only cost $2.12 per piece. The calibre of this rifle was stated to be 0.414, the bullet weighed 312 grains, the powder charge was 62 grains, and the muzzle velocity was 1 430 ft. Russia had, like other nations, experimented with repeating rifles, but had not yet definitely settled on a pattern. She had introduced Evans's repeater into her navy. This was distinguished from all others by the large number of cartridges it held, viz., 35, placed in the butt. He did not think, however, it was likely to be introduced into the army. In the meantime, it was stated in the *Times* of February 19, that a form of attachable magazine had been introduced for the Berdan rifle, which held three cartridges, and which could be fitted with a metal case containing five others, or eight in all, and that this apparatus, whatever it might be, could be fixed in less than ten minutes to the rifle. The lecturer added that though, as the *Times*' St. Petersburg correspondent had stated, official remarks had been made against repeaters, yet, nevertheless, the subject was being considered. Sweden had for some time had the Jarmann rifle, with the magazine under the barrel, but it did not possess any special peculiarities or advantages. Its calibre was 0.397. Switzerland had for some years had the Vetterli rifle, which had a rim-fire cartridge, and was scarcely now on the first rank of weapons. Portugal had recently adopted the Guèdes rifle with the Kropatscheck breech and repeating action. This rifle was distinguished from all the others mentioned by its small bore and high initial velocity. It would be seen, therefore, that every nation had either definitely adopted, or was experimenting with a view to deciding on some form of magazine. We too had, he believed, made up our minds to follow suit, and he ventured to think our authorities were to be congratulated on having determined to do so rather than to re-arm our infantry with an ordinary breechleader, as was proposed but six months ago. After showing the action of most of the rifles mentioned, he presented two rifles, the one known as the Lee-Burton, the other as the improved Lee. Of each of these rifles a limited number would, he stated, be manufactured and issued to the Army for trial, but no pattern of magazine rifle had as yet been definitely settled on for the future armament of our troops. It was, of course, natural that the universal determination to change the armament of European armies should have given a great stimulus to inventors, and he supposed there was hardly a day than did not bring forth a fresh weapon. For a soldier's weapon we wanted our rifle to shoot well and closely at ranges up to 1,500 or 2,000 yards; to have a flat trajectory within the decisive fighting zone, say 600 yards. These two conditions, other conditions being equal, required a high proportion of weight to area of bullet and a high muzzle velocity. The recoil depended upon the weight of the bullet, the weight of the rifle, and the amount of powder. To fulfill the first without unduly increasing recoil and maintain the second as high as possible it was necessary to have a long, light bullet. He discussed this point at length, and brought to notice bullets covered with steel and copper—German inventions—which rendered lubricators unnecessary. He showed that the compound steel projectile, which had probably been adopted for the Mauser, had great penetrating power. He contended that for the new magazine rifle for England we should have experiments to show the best calibre. Speaking for himself, he liked to see experiments conducted under public conditions with bores smaller than 0.4. It must not be forgotton, he added, that a Government rifle-designer had not the free hand a private one had. He could do as he liked with regard to cartridge-case, powder and bullets. The Government official had to consult two other departments, who might not agree in his views. To

have a rifle which should fulfill the utmost necessary quality in a good military arm—namely, flat trajectory—a small bore was an absolute necessity. Personally, he thought that with our present experience a rifle of 0.32 bore with a bullet weighing 336 grs., and a powder-charge of about 90 to 100 grs., would be a desirable combination. There was one objection usually put forward against small bores—that the bullets fired from them were much more affected by a side wind. As a practical fact, a very important consideration was completely lost sight of—that on the field of battle it was the mass fire of numbers, not the aimed fire of individuals, that had to be taken into consideration, and that therefore lateral deviation, considering that we aimed at broad targets of little depth, was of far less moment than flatness of trajectory. This latter was the great object to be attained in a military rifle, and was of far more importance to the soldier than lateral error, however much that might be objectionable to the match shooter. Flat trajectory—*i.e.*, a long depth of shot-swept space—we must have, and to it we must sacrifice, if necessary, some less needed qualities in the rifle. Moreover, in these days the good old superstition, that having a long-range rifle we should endeavor to prevent it being used until we came within the ranges at which alone the feebler weapons of our forefathers were effective, was really dying out, and long-range fire was now universally admitted, and infantry tactics were based on its employment. Long-range fire, breech-loading rifles, magazine arms, all represented as many steps along the path of increasing expenditure of ammunition. The soldier must carry more cartridges; he could only carry a certain weight; to get more rounds of ammunition out of that weight it must be further subdivided; therefore the cartridge must weigh less. In short, a small bore was the logical outcome of modern requirements in an infantry arm. As to the rifling, he pointed to the Hebler, which was 0.0052 in. deep, with bands 0.0195 in. wide, and six grooves. So low was the trajectory that the ground would be practically swept from the muzzle to 650 yards.

He referred to experiments which were being made with powders, and expressed the opinion that with the use of compressed powder better-shaped cartridges would be given. He also drew attention to the advantages of smokeless powder, with which the French had lately been making secret experiments. He divided all forms of magazine rifles into four classes, according to the position of the magazine:—(1) In the butt; (2) under the barrel; (3) over the barrel; (4) under the breech. No nation had the first-named, except Russia, in the Evans repeater. The second had been adopted in France (Kropatscheck), Germany (Mauser), Switzerland (Vetterli), Sweden (Jarman), and Portugal (Kropatscheck). It had the advantage of giving room for a number of cartridges, but the very great disadvantage, which it shared with first position, of being difficult to load. Moreover, the balance of the rifle was altered each time a shot was fired. The German rifle was very faulty in this respect, and was, when the magazine was filled, an extremely arkward and ill-balanced weapon, besides being very heavy, weighing 11 lbs. Over the barrel was extremely awkward for the soldier, and in the case of those weapons which had the magazines on one side, was bad for aiming, especially when the sun was shining from the opposite side to that on which it was fixed. Three forms of rifle—the Burton, the Lee-Burton, and the Owen-Jones—had such magazines.

Underneath the breech was, on the whole, the best. The rifle was more compact and far better balanced. It sole disadvantage was the fact that it was difficult to arrange for more than about five cartridges. The Mannlicher, the Schulhoff, the Pieri, the Lee, and the improved Lee, all had this form of magazine. All held five cartridges except the Schulhoff, which would take ten arranged round a drum like a revolver. In conclusion, he stated that he held the view that in a few months the British Army would be in possession of a weapon as much in advance of what other nations had as the present Martini-Henry was in advance of the old "Brown Bess."

Freezing Soft Material for Excavation.

[Paper read before the Society of Arts at its meeting in Boston, Jan. 27, by Mr. Charles Sooysmith, of New York; reported officially in the Boston *Transcript*.]

THE subject on which it is my privilege to address you has become known to engineers as the "Poetsch Freezing Process." The inventor was Mr. Herman Poetsch, a German mining engineer, of no particular note until he conceived and made a practical success of the method which bears his name. He had something to do with sinking a shaft near Ashersleben, in Germany, to a vein of coal where, after excavating about 100 ft., a stratum of sand 18 ft. thick, overlying the coal, was encountered. It occurred to Mr. Poetsch that the great difficulty occasioned by the influx of water through the sand could be overcome by solidifying the entire mass by freezing. To accomplish this, he penetrated the sand to be excavated with large pipes sunk entirely through it, and a foot or two into the underlying coal. These were placed in a circle at intervals of a meter and close to the periphery of the shaft. They were 8 in. in diameter and closed at the lower end. Inside each of these, extending nearly to the bottom and open at its lower end, was a pipe but 1 in. in diameter. This system of pipes was so connected that a closed circulation could be produced down through the small pipes and up through the large ones. An ice-machine, such as is used for cooling in breweries, making ice, etc., was set up near by and used, to keep at a temperature below zero, Fahrenheit, a tank filled with a solution of chloride of magnesium, the freezing point of which is 40° below zero, Fahr. The solution so cooled was circulated through the system of ground pipes described.

Thermometers were placed in pipes sunk into the mass of the sand, and the following results were observed: the temperature of the mass before the circulation of cold liquid was started was 51.8° Fahr. The circulation was kept up and the temperature of the mass was rapidly lowered, so that at the point where this temperature was taken, which must have been not far from one of the pipes, the mass was frozen the third day after circulation had commenced. The freezing took place, of course, soonest about each pipe, beginning first near the bottom, where the inflowing solution was coldest, and extending outward in radial lines. The cylinders, or, more correctly speaking, the frustums of the cones about the pipes, finally met, thus forming a continuous frozen wall, inside of which the material to be excavated was removed without any possible danger from caving in or inflow of water. The freezing, it was found, had taken place 3 ft. into the coal and to a distance 6 ft. outside of the circle of pipes. The circulation of cold fluid was kept up until the excavation and walling-up were complete.

The brief description of the first work suffices to explain the method in its simplest application. Other shafts were undertaken, and where much difficulty is encountered in passing through water-bearing strata, the process for this purpose is now coming into general use in Europe. For the shaft sunk in Germany, ice-machines with a capacity of 15 tons of ice per day—or, more scientifically speaking, capable of producing 1,750,000 thermal units—have been used. Of course, if we knew the specific and latent heat and the conducting capacity of the material we wish to freeze, we could determine exactly the number of thermal units we should have to extract to solidify the mass. Taking a mass consisting of sand and water in the proportions of three to one, at a temperature of 25° centigrade, and assuming that no heat is supplied to the mass to be frozen, we would have to extract 1,168,000 thermal units per cubic yard to freeze the material. This would permit us, with an ice-machine of 30 tons capacity daily, to freeze 54 cub. yds. per day. Knowing the cubical contents of the mass we wish to freeze, we could, in this way, determine the time requisite for the freezing. In most cases, with the machines that would be used, the frozen wall would be formed in 10 or 15 days. As an actual fact considerable cold is dissipated through the earth. It is very fortunate for us, here, that the soils of the earth and still water are comparatively poor conductors, the

conductivity of water being about $\frac{1}{85}$ that of copper. It remains for some of our students, who have the time, to determine the rate through different kinds of earth saturated with water, and also to determine the strength of these when frozen, so that, knowing the strain upon our wall, we may know how thick it must be to surely resist this strain.

In sinking shafts, as the radial lines of conductivity from the pipes converge toward the center of the shaft, and there is no way for the cold to get out, so to speak, the entire mass inside of the circle of pipes freezes while the desired ice wall is being frozen. This, of course, makes the excavation slow and expensive. Frozen sand and water look like sandstone and seem almost as hard. With pick and shovel workmen in the bottom of a shaft will do very well if they average an inch an hour in depth. Of course, the idea of thawing the interior mass at once suggests itself. Pipes for the circulation of hot brine could be inserted before freezing. My impression is, however, that blasting will prove the preferable method.

Probably the greatest service which this invention will render will be in making practicable the construction of subaqueous tunnels which could not otherwise be built.

In applying the freezing method to the construction of a tunnel there are a number of ways of arranging the ground pipes. Where the depth of water is not excessive, and where navigation or current in the stream do not prevent, it would seem simplest and best to put pipes down from above, in vertical or inclined positions, placing them in rows on either side of the proposed excavation. They can be incased in non-conductors of heat, except the portion about which it is desired to freeze. The circumstances where this manner would be practicable will not often occur. We are more likely to meet with cases like that of the Hudson River Tunnel, where the freezing pipes must be put in from the completed portion of the tunnel, reaching forward beyond the heading. The problem of managing these pipes has been the occasion of a great deal of study, because the heading must be kept frozen, and pipes for further freezing must be kept ahead of this. Then, too, the pipes must be so arranged that they will not interfere with putting in the permanent lining.

The result of my own study on the matter is to place the freezing pipes horizontal and parallel and in a circle near the periphery of the tunnel and somewhere from 3 to 6 ft. apart, as experience shall prove to be the best distance. The brick lining is kept along pretty close up to the excavation. Back at a convenient distance from the heading, in the finished portion of the tunnel, I would have a frame which can be readily moved forward at intervals. Against this frame will be worked the hydraulic jacks, which will be used to push the pipes forward. Occasional bricks can be temporarily left out of the lining to form offsets which can be used to hold the frame in place. Each of the large pipes would have a small pipe inside, extending nearly to the point where a diaphragm, provided with a great number of small holes, would form an obstruction to the circulation. Another small pipe would pass the entire length of the larger one and through this diaphragm.

The ice-machine may be located outside and the cold solution brought through a well-wrapped pipe to the heading. Flexible connection could be made with the system of pipes so that the cold circulation can be maintained throughout the entire length of the pipe, except from the forward point back to the diaphragm. There will be no tendency whatever for the circulation to penetrate beyond the diaphragm. The object of thus limiting the circulation is to prevent possible freezing ahead of the pipe. When the excavation has progressed so that any one of the pipes should be pushed forward, the circulation of cold fluid in it is temporarily suspended, and for a few moments warm brine is circulated throughout the entire length of the pipe, being permitted to flow in through the longer small pipe. The result would be the thawing of a film about the large pipe. While thus loosened the pressure would be put on the hydraulic jack in which the large pipe terminates at the inner end, and by this means the pipe forced forward, say 10 or 15 ft. The circulation of the cold solution would then be resumed. The frozen mass would form a guide for the pipes.

In the case of the proposed subways under Broadway, New York City, the availability of this means of preventing with absolute certainty any lateral movement of the material about the foundation of the buildings, ought to remove all fears of this danger in connection with that enterprise. Where necessary, in a case of this kind, a row of pipes could be sunk close to the curb line, and a frozen wall thus placed between the buildings and the street to be excavated.

This recalls another work of great importance that had to be done with extreme caution, which could have been accomplished with the greatest of security by the new method. I refer to the spreading of the foundations of the Washington Monument, at Washington. Since the monument has been completed there has been considerable said about a stratum of sand which is said to exist below the foundation, and which is feared may at some time be penetrated, and the weight of the monument squeeze it out laterally. If this danger really exists, how easy it would be to freeze a wall about the monument, excavate through this stratum, and put in a permanent barrier to its exit. The freezing process removes also the chief difficulty in the construction of subaqueous tunnels, by sinking them in sections from above, as has frequently been proposed. The chief difficulty in this latter method has always been to make the connection between the sections. To do so by freezing would be readily accomplished by providing the ends of the sections with a pipe running around them outside the tunnel space; then, when it is desired to make the joint between two sections, after filling the space between them with mud, this latter could be frozen, thus forming a barrier to the influx of water while the permanent joint would be made. Another application has occurred to me in studying the difficulties that may have to be overcome in building a railroad tunnel between Canada and the United States, under the St. Clair River, where my firm is now driving a small experimental tunnel. Under the deepest portion of the river there is scarcely enough material intervening between the rock and the bottom of the river to leave a safe thickness overhead while the excavation is made. It may be necessary to provide what I may call an immense turtle-back, which could be lowered on the bottom to serve as a temporary roof. To be effective it should be provided with low, sharp sides, and the entire under surface furnished with channels for the circulation of the cold fluid, so that when lowered on to the bottom of the river the thin roof that would have been dangerous could be converted into a frozen solid, which would perfectly protect the work underneath. Still another application occurs to me in connection with this work. The material at the center line of the proposed large tunnel is such that we anticipate no difficulty whatever in driving the 6 ft. heading which we are now commencing. Better than the turtle-back I have mentioned, it may be to use this trial tunnel as a means of freezing for a sufficient distance about it to permit the excavation of the large tunnel entirely in frozen material. To do this, a car with coils 100 or 200 ft. long, *i. e.*, the coil that length, not the pipe, in which the vehicle of cold could be circulated, could be introduced into the small tunnel and kept immediately in front of the excavation while this latter is made and the permanent lining put in. I believe that no difficulty would be found in freezing 15 or even 20 ft. radially out from this small tunnel by using means of ample capacity. Thus it will be seen that the construction of under-water tunnels, one of the most hazardous and expensive kinds of engineering, has a resource of incalculable value in this new method.

In the construction of deep and difficult bridge foundations, it is likely also to render great service.

Where a foundation is to be obtained on a bed-rock which is very unequal in elevation, and is overlaid by material hard to excavate on account of water, the freezing method is admirably adapted to cope with the difficulties encountered. Where such a pier is to be built in the water, a bottomless caisson or a coffer-dam would have to be first placed in position, and the freezing-pipes put down through or inside the same. Such a coffer-dam may be made with less than the usual care, and earth of some kind filled in around the pipes and frozen. Another

case in bridge construction, where the process could be most advantageously used, would be where it is desired to found a pier on bare rock, where the water is of considerable depth. An open caisson could be sunk on to the rock, being first provided around the bottom with a pipe through which a cold liquid could be circulated after the caisson was settled to place, and sand dumped in about the space between the caisson and bed-rock. When this would be frozen, it would perfectly shut off any entrance for the water, which could then be pumped out and the bed-rock laid bare. The supreme advantage, however, of the process in bridge work will be in obtaining foundations where a trustworthy resting-place is beyond the depth attainable by the pneumatic process, and there are many such places in this country, where bridges are or will be badly needed. It has one disadvantage in comparison with the pneumatic process, in any case where the two methods might otherwise be equally desirable; that is, the excavation has to be completed before any of the permanent work can be started. Whereas, in obtaining a foundation by pneumatic process, the caisson itself becomes a part of the pier, and the masonry is laid on the caisson, while the latter is undermined and sunk. In other words, the pneumatic method would require less time.

It has, however, the disadvantage that the caisson cannot always be sunk in the exact position desired, and the foundation is therefore generally superfluously large, adding in this way to the cost. By first excavating to the bed-rock, the foundation could be built in the precise location and of the exact dimensions desired.

Where a ship has been sunk by collision, making it difficult to close the break, so that she could be pumped out and raised, the opening, however irregular, might be readily closed by freezing.

To accomplish this, it would only be necessary to lower a coil of pipe into or about the opening, throwing something into the latter to impede the circulation of water, and then circulating the brine and freezing the opening fast. In salt water it would, of course, take a very low temperature to accomplish the freezing. It would not be difficult to make an ice machine to produce an excessively low temperature. Those now made for commercial purposes can produce a working temperature of at least 15° or 20° below zero, Fahrenheit.

An early application of the new process is likely to be made in sinking a shaft to a bed of sulphur, discovered several years ago in Louisiana. This occurs at a depth nearly 500 ft. below the surface, and to reach it, beds of sand have to be penetrated where the head of water in same is 300 ft. An effort was made to pass through this, but failed, after an expenditure of, I believe, some $200,000. To sink this shaft, the pipes would either have to be put down the entire length at the start, or else resort would have to be had to some method similar to those mentioned in connection with tunnels; or it might be better to build the upper portion of the shaft so large that near the ends of the first set of pipes put in, an offset could be made, through which a second set could be inserted.

I have now mentioned the peculiar fitness of the Poetsch method for certain classes of work. The chief difficulty in applying it, where there is any difficulty, will be to insert the pipes properly. This difficulty is likely most often to arise from the presence of boulders or logs in the material to be penetrated. It is true this can be overcome by drilling; but it would be very expensive. There has not yet been sufficient experience obtained to enable us to determine the best sizes of ground pipes and the maximum space we dare leave between them. Mr. Poetsch has continued to copy his first success, using 8-in. pipes placed about a meter apart. In some cases the pipes have not been sunk exactly as desired, leaving a space 5 or 6 ft. between them at the bottom; still, the frozen mass was continuous. The fact is that the freezing is due to the cooling of the entire mass in the vicinity of the pipes, and it would seem more a question of total quantity of cold inserted, and distance from the center of application of this than the distance of the point from any individual pipe.

Another possible difficulty that will occur only in rare cases is the presence of considerable quantities of running water through the material to be frozen, which would thus be a vehicle to carry away the cold as fast as supplied. This difficulty is more likely to be encountered in sinking shafts to existing mines where pumping is in progress. As regards cost of doing work by this process, if we except the expense of the possible difficulties just mentioned, we may estimate beforehand the cost of a proposed work, with more accuracy than by any other method; and we may say the same with regard to the time required. This because of the certainty of removing the greatest contingency in such works, namely, that due to the influx of water or soft material. The enemy is converted to an ally and made to stand guard while the victory is won.

In underwater works accidents very often occur from the failure of machinery. Imagine, for instance, what would have happened to the great pier at Havre-de-Grace, had our pneumatic machinery failed, even for a few hours, while we were holding the pier, weighing millions of pounds, on a cushion of air. With a frozen wall several feet above us, we would have been in safety while any conceivable accident to the ice-machinery could be repaired, as it would have taken several days, or at least many hours, for dangerous thawing to occur. It has been customary in Europe, and will probably always be advisable, to keep the ice-machine running until the permanent work is put in place.

Difficulty might be anticipated in putting in a brick or masonry wall close to the frozen material. As a fact, no difficulty has been experienced in doing this.

The Old World was a more favorable field than the United States for the development of this process, because the coal fields have been more completely exhausted, and the time was ripe for the invention of a means of reaching the more inaccessible ones. Until three decades ago it was deemed practically impossible to bridge the Missouri or the lower Mississippi, or to obtain adequate foundations in many other places where the difficulties have since been successfully overcome by the pneumatic process. And just as this has rendered easy and of common occurrence the execution of works not long ago regarded as impossible, so this freezing method seems destined to make a step forward of no less importance.

Lake Shipbuilding.

(From the Chicago *Tribune*.)

THE outlook for the coming season's lake-carrying trade is so flattering that vesselmen have not only advanced their rates very considerably, but they have generally concluded that more ships can be profitably employed. They have, therefore, rushed their orders into the shipyards from Buffalo to Milwaukee, and shipbuilders are now as busy as bees, hurrying to complete as many vessels as possible in time to catch at least a portion of the coming season's traffic. The vessels which are now being built are not little schooners, such as were turned out in former days, but almost all of them are large steamships, averaging over 2,000 tons in carrying capacity. A number of them will have wooden hulls, but the largest and finest vessels will have steel hulls, while their appointments are generally of the most approved style of marine architecture. Great strides have been taken in this respect by the lake shipbuilders during the past few years, and their work will not suffer when compared with that of the seaboard builders.

The greatest activity in lake shipbuilding is at Cleveland, Ohio, where 16 vessels are in process of construction at the present time. Next in importance are Detroit and Bay City, Mich., at each of which places nine vessels are under way. At Buffalo, N. Y., three steamships are being built, and the same number at Trenton, Mich. At Milwaukee, Wis., two are under construction, while at a number of small shipyards at various locations on the lakes single ships are being built. The Cleveland vessels will cost from $120,000 to $265,000 apiece, and will each carry from 2,000 to 3,000 tons of freight. The Detroit vessels are of greater variety, ranging from 1,200-ton

barges to 2,650-ton steamships, and costing from $75,000 to $275,000. The Buffalo vessels are all large, from 2,000 to 2,800 tons, and will cost from $135,000 to $300,000. An estimate of the total number of lake vessels now being built, their carrying capacity and cost is as follows:

Port.	No.	Tons.	Cost.
Cleveland	16	36,500	$2,340,000
Buffalo	3	7,600	735,000
Detroit	9	16,200	1,301,000
Bay City	9	18,600	1,060,000
Trenton	3	5,800	315,000
Marine City	1	2,300	120,000
St. Clair	1	2,400	130,000
Milwaukee	2	4,500	270,000
Grand Haven	1	2,500	130,000
Mt. Clemens	1	200	4,000
Baraga	1	1,600	35,000
Total	47	98,200	$6,440,000

In looking over this table it is worthy of remark that Chicago is not found in it. The City of Chicago has vast commercial interests, second to no other city located on the lakes, and its merchants and business men are heavily interested in shipping, owning an important part of the new vessels being built elsewhere; but it has no shipyard. In this respect Cleveland, Detroit and Buffalo, to say nothing of still smaller cities, cast it completely in the shade. This is all the more remarkable, as Chicago business men are alert and progressive, having distinguished themselves in every branch of the iron and steel trades into which they have embarked. If a modern iron and steel shipyard can be sustained at Buffalo, there would certainly seem to be hope for one to succeed at Chicago.

Indian State Railroads.

AT the close of their last fiscal year the state or government railroads of India included 5,350 miles in operation, and there were in addition 2,265 miles under construction, and 435 miles under survey. These lines were divided as follows:

	In Operation.	Under Construction.	Under Survey.
Imperial lines	3,010	1,204	67
Provincial lines	1,554	286	54
Imperial lines worked by companies	316	715	289
Native State lines	470	60	25
Total	5,350	2,265	435

The *Indian Engineer* says: "The rate of progress in opening up new lines is, to say the least, disappointing. During the official year ending March 31 last, only 264½ additional miles were added to the State railway system, and for the six months from April 1 to September 30 last, the new length opened amounted to only 72 miles. It is not to be wondered at that with so miserable a speed of development the 'indirect' charges and the ordinary establishment expenses debitable to capital should attain such extravagant proportions. But such has been done of late toward economizing these charges, and the lines now being opened up by the State, and the assisted companies, will, it is believed, show greatly reduced figures for these accounts. The over-cautious system followed by the Government of India, requiring the strictest scrutiny into small and unimportant details, and the withholding of sanction to the whole undertaking until some trifling local question was finally arranged, has had much to do with the tardy rate of progress that has characterized the development of railways in this country from the beginning of operations down to the present time. It is generally admitted that the staff forming the Indian Executive is as efficient as any similar body of officials in any other part of the world; but no liberty of action is allowed, and therefore there is a small chance for the officers to distinguish themselves.

"Excluding the East Indian, and omitting the Imperial lines worked by companies or owned by native States, the Government of India possessed on December 31 last 4,564 miles of railway open to traffic, and 1,490½ under construction, besides 121 miles under survey. * * *

There is a marked reduction in the expenditure on construction and equipment on the lines lately brought under traffic, and there is reason to hope that the days of obstruction and petty interference from supreme headquarters are henceforth to be numbered among the things of the past. Of the 2,265½ miles under construction 643¾ are classed as 'Political,' being a part of the Sind-Pishin and Sind-Sagar extensions, including 57 miles of the temporary Bolan line. The Indian-Midland had 311¾ miles; the Southern-Mahratta, 403½; the Nagpur-Bengal, 287½; the Assam-Behar, 124¼; the Lucknow-Sitapur-Kheri, 124; and the Bellary-Kistna and Cuddahpah-Nellore 208 miles of works in hand at the end of the year. The portions under survey were confined mostly to 289 miles of the Indian-Midland, 54 of the Assam-Behar, and 45 miles of the Nagpur-Bengal; but since the close of the report under review, December 31 last, many other important surveys have been decided upon, a part of which, together with the preliminary estimates, etc., are either completed or in a forward state. In the proposed extensions we are glad to find that Madras is to receive its fair share, for 631 miles—414 'Imperial' and 217 'Local'—have been under survey during the current year, and actual work is expected to commence on several sections during 1887."

Photographic Map Reduction.

[Paper read before the Engineers' Club of Philadelphia, by O. B. Harden.]

THE reduction of maps and plans, forming as it has a large part of the work of the drawing office of the Geological Survey, has led to the constant use of the camera in reducing and duplicating the maps which have been placed at its disposal; and believing that its general use would be to the interest of engineers I desire to call the attention of the club to this method of reduction.

The first use of the camera by the survey for this purpose was in 1883, when it was desired to have a quicker and cheaper method of reducing the large mine maps of the coal-operating companies to the working scale of the survey, a reduction of from 100 ft. to 600 ft. to 1 in. It was found to be so large a saving of time and labor (having up to this time used the pantagraph) that all the maps since that time, of any magnitude, have been so reduced.

Having made use of the existing information in the special areas in which work has been prosecuted, it has been frequently necessary to have maps reduced and duplicated in the shortest possible time, in order that the original maps might not be long away from the offices in which they were frequently used. This is especially true of railroad maps. The time necessary to do this became a matter of importance, and as the most accurate, quickest and cheapest means of reduction, they have been reduced by the camera.

The maps have been of a variety of scales, from 100 ft. to 1 in., to 6 miles to 1 in., and have been reduced as small as 10 miles to 1 in. It has not been found that the size of the reductions affected in any way their accuracy. It may be remarked that, however small, there is that fidelity in detail that is only equalled by the photographic lens. To those who are accustomed only to the more common methods of reduction and the fallibility of the ordinary draughtsman, this fidelity to detail is gratifying. Even by the use of the pantagraph and rectilinear lines, the reduction may be accurate in length and breadth and yet be perceptibly wrong within a square, dependent upon the care of the draughtsman.

In many cases the mine maps reduced, being in the conventional color of the bed, have not photographed well, especially so in the case of ultramarine and purple shades, which have to be strengthened on the print in order to be observed through the tracing cloth. This is so with the specimen prints of the workings of the Pennsylvania Coal Company.

The beautiful regularity of the mine workings shown in these reductions is a marked feature.

The originals of the alignment of the Pottsville & Mahanoy Railroad were drawn in colors, black, chrome-orange, purple, red and green, and as shown on the prints it has been necessary in the case of the red and purple lines to strengthen them. I desire to call special attention to these prints as being typical of the work of Messrs. Julius Bien & Co., of New York, who do this work for

the Survey. The green color having been made up of yellow and blue, the yellow on the original has separated and produced a heavy blurred line. The contour lines are drawn in chrome-orange. The lines drawn in black appear the most distinct, hence it is preferable that maps should be in black to photograph well.

The scale of these prints is 1 mile to 1 in., reduced from 1,000 ft. to 1 in. It is necessary in joining them together that it be quickly done and as little paste used as possible, as the paper is very sensitive. It is more expeditiously done by overlapping the prints and pricking holes through two common points on each, mark out and cut off the one print to overlap the other half an inch, paste the lower print and stick the pins back into the same holes; the two prints are then coincident.

There is practically no limit to the size of map which may be photographed, as it is only exposed to the camera in sections of about five feet square, when the negative required be as large as 21 × 25 in., this being the largest size taken by Bien & Co.

The maps are reduced to their proper size by the operator tacking a strip of paper with the original scale upon it above the section of map to be reduced, another strip being cut the reduced size and held up to the ground glass of the camera until it is so focused as to be the required scale.

The only element of error entering into the reduction of maps by the camera, aside from the care and skill of the operator, is the expansion and contraction of the sensitive paper. It should, however, come back to its original size after immersion; if it is found not to do so, an allowance is made by making the scale larger or smaller as the case may require. The accuracy of the reduction depends as much upon the perfect adjustment of the map at right-angles to the line of sight as to the scaling by the operator.

It is unnecessary more than to mention that there is no error due to distortion, this being compensated for by the combined lenses used for such work.

The largest maps reduced for the Survey are the splendid topographical maps of the Philadelphia Water Department, being the results of its surveys for a future water supply for Philadelphia.

These maps cover an area of 446 square miles in Montgomery and Bucks Counties, and have been reduced from 400 ft. to 1 in., to 1,600 ft. to 1 in. The area of original map-surface is about 773 square feet. The area of map-surface of the prints when put together is about 193 square feet. The reduction of this immense surface has been made in 30 negatives. The maps are made in colors, the roads yellow, the timbered areas green, the buildings in red and the streams in blue.

In order to prevent any errors resulting from the shrinkage or imperfect joinage of the prints, a templet will be constructed for the final map with the lines of latitude and longitude on a polyconical projection drawn upon them, these lines being on the original map.

A comparison of the cost shows that there is a saving of about 40 per cent. over the other methods of reduction. This is where a reduction alone is required and where the map will answer its purpose upon the sensitive paper; where, however, the map is required upon tracing cloth, or where it has to be transferred to a more substantial paper, the saving is about 30 per cent.

Steam Ferries vs. Large Bridges.

[Major W. Sedgwick, R. E., in the *Indian Engineer*.]

THERE seems to be at present upon our railroads in this country a rage for building large bridges, and an innate antipathy to everything in the shape of river navigation.

From the last Administration Report of the Railroads in India, it appears that in 1885–86 there were at least nine large railroad bridges under construction in Upper India alone.

Now we may perhaps assume with safety that the construction of these nine large bridges with their approaches and protective works will involve an expenditure sufficient to have built and equipped 500 or 600 miles or more of broad-gauge railroad with a surface track; and five or six times as great as the amount which would have been required if steam ferries had been used instead of bridges.

The worst of it is that, in view of such heavy expenditure, people will be apt to imagine that we must be making great progress in railroad construction; although in reality the expenditure on large bridges is being incurred mainly in substituting one method of crossing large rivers for another, much more troublesome indeed, but at the same time less costly by far.

It is not of course possible for a moment to doubt the vastness of the importance of large bridges in a wealthy country, nor the grandeur of the service rendered to the world at large by those who, as at the two Hooghly bridges, have shown us improved ways of constructing large bridges; neither can it, of course, for a moment be doubted, that if funds in plenty were available for railway work it would be well to build large bridges freely in India. But as large bridges are very costly and money is scarce, and the want of funds prevents the construction of a multitude of lines which are indispensable for the development of the country, it may be worth while to consider whether India could not for the present get on very well without large bridges. The necessity of looking into the matter at this particular time arises from the fact that the successful completion of bridges, such as the Hooghly and the Sukkur bridges, will certainly bring into the field many other projects of a similar kind, but doubtless, in some cases, on a more extensive scale.

If we do not bridge our large rivers, we must, of course, put steam ferries upon them. It may be worth while, therefore, to look into the working of some of the existing steam ferries with a view to ascertaining their capabilities, and whether there is any real reason why we should not be contented to use them on our large rivers in the present condition of India, in place of building expensive bridges.

We find then, from the Administration Report before referred to, that the Indus Valley State Railroad has practically demonstrated the possibility of sending loaded railroad carriages or wagons or even locomotives bodily across the largest rivers by steam ferries, to any extent which can possibly be required, by actually sending no less than 93,483 broad-gauge wagons and 50 locomotives across the Indus at Sukkur in 1885, or an average of over 250 broad-gauge wagons per day; and thus have shown, also, that it is quite unnecessary to put, as is now ordinarily done, passengers to the inconvenience of turning out of their carriages at a ferry perhaps early in the morning or late at night when they have comfortably settled themselves for a long journey; and add thus to the many annoyances which have to be endured in railway traveling in India; and also that, it is quite unnecessary to put the staff of the railroad to the trouble of unloading wagons into flats at a ferry, and then the flats again into wagons, and getting consignments sorted after they have been mixed up upon the flats; since carriages and wagons alike can be sent bodily across by the ferry with their loads. The North Bengal State Railroad has shown, at the ferry over the Ganges at Sara, that the detention at a ferry, even in the case of the largest and most troublesome rivers, need not be greater than the ordinary detention at a large junction between railways owned by two different companies; and has shown also that by arranging to give passengers one of their meals upon the ferry steamer the detentions at a ferry can be utilised, and a long stoppage at some other point upon the road thus avoided. The North Bengal State Railroad has further shown that a steam ferry can be worked by night as easily as by day, if the river channel is regularly surveyed and marked out by colored lights; and has thus done good service not only to steam ferries, but also to the cause of Indian Inland Navigation by making it clear, that if we will go to a comparatively little expense annually in surveying, improving, and lighting the channels of our great rivers, steamers will be able to run over them by night as well as by day; and our magnificent Indian waterways will then take their proper place as subsidiary lines of communication of the cheapest

and most useful description, instead of being neglected and despised.

We do not find, however, that any railway has as yet made a serious attempt to diminish the difficulty of working a ferry on a river with a wide and shifting channel; but it would appear that, so far, railways have been contented to go on putting down ghât stations and taking them up again each time the river shifts its channel, perhaps even twice in a year. And yet there seems no reason to doubt that it would be quite possible to have permanent ferry stations, even at the most troublesome rivers, by simply arranging to lead the river to some permanent site upon the railroad by steamer canal, instead of leading, as is now done, the railroad to the shifting river's edge by a ghât line and station. In the construction of steamer canals it would often be possible to utilize the channels of nullahs or khalls; or failing these, the river itself, when in flood, could, if the flow were directed by a suitable arrangement of mat bunds through a small cut so as to enlarge the cut by the scour, be made to do much of the necessary excavation.

If the river cuts in after a steamer canal has been constructed, the length of the canal will simply be shortened and the canal thereby improved; and, if the river goes off, the canal can easily be extended so as to meet it again; and no other alteration beyond some dredging annually will be necessary. But in the case of a ghât station the whole station has to be reconstructed at great trouble and expense every time the river changes its course, whether it cuts in or whether it goes off.

In any case it would seem clear that the present defects in steam ferries can be got rid of to a great extent by adopting improved methods of working.

But having looked thus at the defects of steam ferries, we may now glance at their advantages, and it is *quite* clear that they offer in some respects decided advantages; for we find, in the first place, that in the matter of cost the capital outlay on a steam ferry is small in comparison with that on a large bridge. Thus we find that a steam ferry across the Ganges on a scale sufficient to take the traffic of a railroad such as the North Bengal or the Tirhoot State Railroad does not cost more than $180,000 to $215,000, though the channel crossed at Sara or Mokameh is two miles or more in width, and the capital cost of a bridge would certainly be 10 or 12 times as much. And then the cost of working a steam ferry can be entirely recouped by levying a special charge for the ferry, while no extra charge can be levied on account of a railroad bridge; although the annual charges for interest on capital expenditure upon a large bridge, with its protective works and approaches, will alone, if loss by exchange is allowed for, cover the entire working expenses of a steam ferry, as is very plainly shown by the Administration Report of the Railroads in India. From these reports it appears that the Sukkur ferry over the Indus was worked in 1885 by the Indus Valley State Railroad at a cost of $74,867, and that the cost has a tendency to fall rather than to rise; for we find that in 1881 when 31,976 wagons were sent across by the ferry the cost was $61,259, and in 1883 when 62,353 wagons were sent across, $76,599; while in 1885 when 93,483 wagons were sent across the cost was only $74,867. It appears also that the cost of working the steam ferry on the Tirhoot State Railway over the Ganges at Mokameh fell from $45,555 in 1884 to $40,088 in 1885.

But if a ferry such as that over the Indus, at Sukkur, with 250 broad-gauge wagons, on an average, to be sent across daily, can be worked at an annual cost of $74,867; and the traffic of the Tirhoot State Railway in 1885 across a river two miles in width, such as the Ganges at Mokameh, at a cost of $40,088, it seems plain that the annual charges for interest on capital outlay on a large bridge, with its approaches and protective works, would in any case fully cover the working expenses if the large bridge were replaced by a steam ferry; while in addition to charges on account of interest, there are maintenance charges and charges for depreciation on account of the gradual deterioration of the superstructure and for flood damages to be allowed for in the case of the large bridge.

The steam ferry has a further advantage over a bridge as a means of crossing large rivers by giving much greater freedom in the choice of an alignment for the railway, and in requiring no delay during construction and also in admitting of easy removal, if it should be necessary, for any reason to shift the site of the crossing.

Hence it would seem that both from a financial and from an economical point of view the steam ferry has, along with its defects, decided advantages over the the bridge in the case of large rivers.

Whatever, then, rich countries may do, it would seem that, in a poor and undeveloped country, such as India at present is, we should do well to keep to steam ferries at large river crossings, though insisting indeed on improved methods of working being adopted at our ferries so as to do away, at least, with the necessity for turning passengers out of their carriages, or breaking bulk in the case of goods traffic; and should do well to discourage all projects for large bridges except in special cases.

In regard to the military side of the question, we must not forget that large bridges in India are liable to be damaged not only in the ordinary course by railroad accidents and by floods, but also in times of disturbance by dynamite, and by derailments of rolling stock designedly brought about. And it is beyond question that the native staff, by which, to a large extent, all our railroads are now worked, will form a weak point in our communications in times of disturbance, which will increase greatly the difficulty of guarding our large bridges in these days when destructive appliances have been brought to such a state of perfection that a native, whose dark skin and stealthy approach will be perfectly invisible at night even to the most vigilant of sentries, will be able to carry and affix charges sufficient to damage hopelessly the superstructure of a large bridge.

Besides, in the case of large spans, it may be well to remember that we have at present no means of forming an opinion in regard to the durability of the superstructure, which may possibly fail much sooner than we imagine under the effect of vibration transmitted through long distances, and therefore, in all probability, through some weak places; transmitted, too, in the case of cantilever bridges, through more or less open joints at the centilevers, and therefore, to some extent, by blows.

The Electric Lighting of Trains.

(From the *Electrical Review.*)

MESSRS. R. E. CROMPTON and J. Swinburne have recently patented some improvements in the electric lighting of trains, which appear likely to be of considerable value. One of the difficulties in train lighting is that if the dynamo is driven from the axle it does not go at a uniform speed. To get over this difficulty, the inventors adopt the following arrangement: The dynamo is driven off a countershaft, which is driven off the axle of a carriage or van. The countershaft is in the same horizontal plane as the axle, so that the movement of the carriage, relatively to the wheels, does not affect the dynamo. The dynamo is in connection with secondary cells. The field magnets are wound with two wires: one is in shunt to the armature as if the dynamo were an ordinary shunt machine wound to work at a low speed, say 500 revolutions. The lamps are in shunt to the armature also; but the cells are so connected up with the second wire that if the dynamo charges them the current goes round the field magnets by the second wire, so as to demagnetise them. Thus the dynamo is like a compound machine wound to work with a low speed, and having more main than usual, and that main coupled up backward, the lamps being in shunt to the armature only, and the cells in series with the backward-wound main. The result is that as the speed increases above 500 the dynamo charges the cells, but the pressure on the lamps does not rise much, as the field is demagnetised by the current going to the cells. The second wire is so arranged that at the maximum speed the cells take their maximum charging current, which demagnetises the fields to the right degree. If the speed falls below 500, the cells begin to help the dynamo by supplying part of the current to the lamps, and in so doing they magnetise the field more strongly, so that the

dynamo does not stop giving current till it goes at, say, 300. The second wire or backward main is made thick, so that there is little loss of pressure even with a large current to the cells.

As the train sometimes stops and sometimes goes backward, means must be taken to prevent the current from the cells from burning the armature up when stopped. The inventors state that the method they find to answer well in practice is to have a cut-out in circuit to break the armature connections when the speed falls below a certain value. The dynamo is driven in the usual way, so that when the train stops or reverses the dynamo does so too. In this case the brushes must be shifted on reversal. To effect this the brush carrier or cross-bar is mounted on the axle so as to turn with it, but is held by adjustable stops, so that if the machine goes one way the brushes go round until the stop holds them in the right position for that direction of rotation, and if the train goes the other way the brushes are carried about half a revolution until they come to the other stop. Tangent brushes, or brushes that will allow the commutator to run either way under them, are used.

A centrifugal or other suitable governor works a cut-out which cuts out the armature when the speed is too low, and puts it in again when high enough. This governor may also cause the short-circuiting of the backward main when the armature circuit is broken. It may be mounted on the dynamo shaft.

Instead of a speed cut-out an electric arrangement may be used which is actuated by the armature electromotive force in making circuit, and by the discharge of the cells in breaking it. There are many ways of doing this by double-wound electro-magnets; and the field magnets may be made to polarise the cut-out.

Electric Motors.

[Abstract of address delivered before the National Electric Light Association at the Philadelphia meeting, by Mr. J. F. Sprague: reported by the *Electrician and Electrical Engineer.*]

THE time has come for us to look upon the distribution of power in a light altogether different from that in which it was viewed three years, or even one year, ago. We have heard about electric motors, and we have talked about the possibilities of the transmission of power ever since Pacinotti ran his first motor. But motors were run primarily with batteries, and it is only recently that they have been operated in connection with central stations.

They have been made of small sizes and treated as toys, and more batteries and motors have been invented than there have been made variations in the steam engine, but we have never reached any position from which we could show a commercial return from the use of electric motors until the last year or two.

The distribution of power by electricity, so long looked upon as a visionary and to-be-hoped-for attainment, is now an accomplished fact. It is in its infancy, but it has a future probably second to no other enterprise in the commercial world. It is not necessary here to give a sicientific explanation of the operation of a motor.

The practical questions which arise are: Who are to exploit this business? Who are to be actively interested in the extension of this system for the transmission of power?

There are two representative industries already in the field. The first to come was the arc light; then the incandescent light; and now, finally, comes the transmission of power for industrial purposes. There have, in consequence of the order of development of these three different methods of using electricity generated at a central station, arisen three different interests, more or less antagonistic to each other, but which ought to be working in harmony.

As being in the position to actively take up this work, I may mention, first, arc-light companies.

A very large number of existing companies have already secured franchises which it would be difficult for other companies to obtain. Some of these companies are to-day just barely meeting their running expenses, because they are supplying power for lights for only a fraction of the day or night in close competition with the gas interests, and perhaps with other electric light companies. As the demand for light varies, of course, at different times of the year, the receipts vary above and below the operating expenses. All through the day, till perhaps five in the afternoon, these stations lie idle. Such companies have their poles erected, their lines run, and certain franchises in their possession, and it would be an easy matter for these same companies to run lines for the distribution of power on the same poles as carry their arc-light circuits. The wiring for this purpose would be very simple. In some cases the poles would have be to re-enforced; in others it would not be so. For running these lines to supply power alone, constant potentials as high as 400 volts could be used with perfect safety, and this would very much reduce the size of the wire.

As regards incandescent light stations, many of these run only in the daytime, and do not begin their lighting until late in the afternoon. The bulk of their lighting terminates long before midnight. Other of these stations run during the day because they find the necessity of supplying a few lights in the daytime to get certain contracts for night-work, but almost invariably this day-work is at a loss. These companies already have their lines run to supply power on constant potential circuits, some overhead and others underground. Since the power would begin in the morning and continue for a general average till the latter part of the afternoon, and then begin to fall off, and the light at the same time begin to come on, such a station, if worked up to its full capacity, ought to have an almost continuous load from morning until late at night; the load consisting first almost entirely of power, then of light and power combined, and finally almost entirely of light.

The gas-engine, although it has made great strides in England, does not stand in high favor to-day in the United States. A gas-engine will not work up to the capacity at which it is sold and at which it is nominally rated. It will fall off anywhere from 25 to 50 per cent. below this. Its motion is necessarily irregular and uncertain, because during a large part of its rotation it is dependent upon the inertia of the fly-wheel. Such machines are necessarily more costly than electric motors of the same capacity, such cost being about double. They are noisy, they cause a great deal of heat, and they are uncertain. Their advance in England was made before electric motors were as practical as they are to-day, and where gas is sold at a very much lower rate than it will be possible to get it for in the United States for many years to come. The electric motor, then, can easily compete against the gas-engine when put side by side, both in initial cost and expense of operation. It is likewise more compact and has an excess capacity, a quality that is never claimed for a gas-engine. Gas-works have among their residual products coke, which is of very little value. By putting in good generators, running wires for the supply of power alone, and putting the generators and dynamos in charge of the men who are already employed at the gas-works, they could produce their power and sell it at a very advantageous price. Their office rent, officials' salaries and attendance would be reduced to a minimum.

Special stations should be put in good manufacturing and industrial districts, and preparations made to supply any demand for power from a half H. P. up to 100 or more H. P. There is no possible question that, when a large number of motors are supplied from one district, even when dealing with large powers, electricity can successfully compete against steam.

Double circuits can be used, small powers being supplied at 100 volts, and large ones at 400. Such stations should be built to get the steam power at the lowest cost, and hence should have the best engine and the best method of fuel consumption. The district covered will depend upon the location of the station. If this is central, wo or four square miles can be easily covered.

I will now consider the different classes of circuits on which motors may be used.

1. Arc-light, or constant current circuits, in which the

current supplied to the motor is kept constant at a certain number of amperes, ranging from 6 to 19 amperes in different systems. The electromotive force at the terminals of the motor varies with the load.

2. Constant potential, or incandescent light, circuits, in which the difference of potential at the terminals of the machines is kept practically constant while the current varies with the load.

3. Circuits in which the current and the potential both vary, as is the case where there is an appreciable drop or fall of potential on connecting lines somewhat removed from the source of power of a constant potential system.

I am now operating on all classes of these circuits, but since, because of the small ampere capacity of the current on arc-light circuits, any large power must require a great difference of potential at the motor terminals, and variations of power will cause sudden and great changes of potential, the arc-light circuits have principally been used in conjunction with arc lights for transmission of small powers only, or for constant work.

In considering the transmission of power as an industry, that is, in a broad and comprehensive way, and not as an adjunct to some system of lighting, I may here state that practical and theoretical considerations make it imperative that the constant potential method of distribution is the only safe and feasible one. Since I make this statement, it is incumbent upon me to explain the reasons. The only existing constant current circuits are used primarily for the operation of arc-lights. At present, as I have said, these range in capacity from 19 to 6 amperes. The unit of light which is required for general purposes necessitates an expenditure of about half a horse-power of electrical energy. A greater expenditure would be extravagant. In order to keep the size of the conductors as small as possible and to allow long extended circuits, the tendency is to reduce the amperes to the smallest number. The conditions of an arc-light probably will not allow this to go below about 6 amperes; the more ordinary unit is about 9½. The commercial conditions unquestionably will not permit, in the future, of a much higher ampere capacity, because the size of the wire varies as the square of the current used. Now, with a 9½-ampere current, a motor to develop one H. P.—supposing it to have an efficiency of 80 per cent.—must have supplied to its terminals 933 watts of electrical energy. In other words, there would be at the terminals of the machine an electromotive force of about 98 volts for each horse-power developed. Suppose, now, we want to transmit 100 H. P.; it would then be necessary (if the motor be of the same efficiency) to supply to the motor 93.250 watts of electrical energy; and, if it were on this 9½-ampere circuit, we would have an electromotive force of over 9,800 volts.

Now, in practice, arc light circuits vary from, say, 1,000 to 2,500 volts. On a 1,000 volt circuit you could recover about 10 H. P; on a 2,500-volt circuit about 25 H. P. In other words, existing arc-light machines, if devoted entirely to the transmission of power, are limited to the actual development, on even the largest machines in ordinary use, of 25 H. P.; and, if used in combination with light, there would not be available on any particular circuit over a small fraction of this. Now if you are going to consider motors as toys, if you are going to deal with the transmission of the tenth of a horse-power or one-half H. P. or a 1 H. P. unit, and are willing to have the element of danger as well enter into these small transmissions, then you can work with an arc-light circuit; but if you are going to transmit units of 5, 10, 15, 20, or 25 H. P., you cannot deal with the arc-light circuit; it is utterly impossible.

In Boston we have recently put upon certain lines nearly 200 H. P. Suppose this were supplied on 9½-ampere circuits. No less than 8 circuits of 2,500 volts each would be required, and probably more, because with units as high as 15 H. P. and this division of circuits, the law of general average could come into play in but a very limited way.

These eight 2,500-volt circuits represent the capacity of a 460-arc lamp station, and to deliver the power not a single lamp could be used at the same time. Does any one really suppose that by this method of working, leaving out for the present all questions of danger and unreliability, the same results could be obtained as are in fact to-day? The constant current method of distributing power is the limited and unnatural method; the constant potential, the comprehensive and natural method. This is a fact entirely independent of the question of relative electrical potentials, because on the constant potential circuit we can work at 100, 500, 1,000 or 2,000 volts if we please.

In Boston we at present transmit up to 4,800 ft. on a 200-volt circuit.

When dealing with the question of power alone, and with an area of say four square miles, the station being near the center, I would prefer to work with 400 volts. Remember, then, that power transmitted means the transference of a given number of watts of energy. It is expressed by two products, quantity and pressure. If one is increased, the other may be reduced. If small conductors are to be used, then it is essential that small currents shall be used, and of necessity high electromotive forces, even when operating on a constant potential circuit.

When dealing with short distances and small powers, it is better to use low potentials; but, when dealing with large powers and long distances, it is absolutely necessary to use high potentials, because the commercial conditions will allow only a certain proportionate investment in copper.

Electrical Progress in Japan.

[Paper read before the National Electric Light Association at the Philadelphia Convention, by Prof. Fujioka.]

As my present visit to this country, with Mr. Yashima, President of the Tokio Electric Light Company, Japan, is to investigate the different systems of electric lighting and electric transmission of power, which are now in actual use here, so that we might introduce to our country the best and most reliable system, and not to make advertisements of our work, if any, I am not well prepared to give you any clear sketch of the progress of electrical engineering in our country, and I think this short paper which I have the honor to read now before such a remarkable body of electrical men as the National Electric Light Association, would be nothing but curiosity to you.

To begin with the electric telegraph, the first line was put up in 1869, if I remember right, with Breguet's A B C instrument. Since then many improvements have been, of course, introduced, and now nearly all the towns, small or large, are electrically connected, so that we can telegraph from any part of our country to any part of this country, or anywhere else, only it is rather expensive, *i. e.*, about $2.80 per word, from New York to Tokio. The instruments we use at present are mostly Siemens-Morse ink writers; and the wires are all overhead, except some wide rivers and straits, where, of course, subterranean cables are used. The Japanese telegraphs are completely under Government control.

It was in 1872 that the Imperial Engineering College was instituted in Tokio, and Prof. W. E. Ayrton, the well-known electrician, now in London, occupied the chair of the Professor of Telegraph Engineering and Natural Philosophy, and stayed there for six years, working in the line of electrical researches with Prof. John Perry, then Professor of Mechanical Engineering in the same college. These two gentlemen's names are pretty familiar to you, I guess, from their valuable labors in relation to the electrical engineering and the ammeters and voltmeters of their invention. Mr. Thomas Gray, assistant to Sir W. Thomson now, was with us in the college for about three years, and I have been connected with the college for a number of years, attempting to keep up with the progress of electrical applications abroad. I was here in 1884, when the International Electrical Exhibition was held in this city.

The telephone business is yet quite poor in our country, only the Government offices and residences of high authorities being connected. Petitions for permission of organizing telephone companies of exchange system are

made from time to time, but the Government does not permit it for some reasons or other, which I cannot tell. I believe, however, it will be permitted sooner or later.

Now, as regards electric lighting, we have the Brush arc lights in some factories, mills and dock-yards, and the Edison incandescent lights in some places, and among others may be mentioned 500 lamps in the Osaka Cotton Mill, and 330 in the Imperial Military College.

On many occasions, such as at the ball of the Minister of Foreign Affairs Department, on his Majesty, the Emperor's Birthday, *i. e.*, November 3, at the opening ceremony of the Banker's Meeting Place, and the like, we put up temporary plants with good success, and the result of this, together with the most satisfactory reports on the Edison incandescent lighting in the Osaka Cotton Mill and the *Official Gazette* printing office, induced our people to favor the electric lighting with great eagerness. The Tokio Electric Light Company, which was organized some time ago, and of which Mr. S. Yashima (now in this room) is the President, has a capital of $200,000, and by the end of this year this capital will be doubled. The company has in hand the contract of lighting the new Imperial palace with 2,000 incandescent lamps and 100 arc lights from the company's central station, located just outside the palace ground, and from which the current will also be supplied to the residences of the princess and ministers and other houses around it. It is proposed to place five or more central stations in the City of Tokio, two in Osaka, one in Kyoto, two in Nagoya, and other places. Considering from the fact that the City of Tokio is 10 miles square, with a population of 1,000,000, and that there is now only one gas company, charging $2.50 per 1,000 cubic feet of gas, and having old-fashioned gas furnaces, the Tokio Electric Light Company has a great deal to do toward the illumination of the city.

In conclusion, as there are many printing offices and small factories all over the city, using at present numerous men or steam engines, ranging from one-half to 20-horse-power, the electro-motors will also, without doubt, find good places there. I hope, gentlemen, I will be able to read a better paper when I see you next time.

The French Railroad Jubilee.

THE great railroad companies of France, acting together have made public the following statement:

"It is well known that a committee is making arrangements to celebrate in 1887 by a special exposition at Vincennes, a congress and fêtes, the semi-centennial of French railroads. This committee having made a new attempt to obtain the coöperation of the six great French railroad companies, those companies have felt obliged to decline the proposition, which was made to them in the most courteous manner, and to persist in their resolution not to associate themselves with this work. They are unanimous in regarding it as contrary both to historic truth and to the interests of the exposition now in preparation for the centenary of 1789.

"In the first place, as they have heretofore remarked, the beginning of the construction of railroads in France dates back to a period prior to 1837, and to celebrate a semi-centennial in 1887 would be to give the impression, contrary to the reality, that France had been notably left behind by other nations.

"In the second place, to organize a special exposition of railroads and the different industries attached to them only two years before the great industrial celebration of 1889, would be, the companies think, to deprive that celebration of a part of its attraction and its success; the six companies therefore believe that they ought to reserve all their efforts for the national celebration of the centennial.

"Finally, the companies recall the fact that a congress similar to that proposed by the semi-centennial committee was established by the International Association of Brussels, which was formed in 1885, and which has continued to act since then by the regular meeting of delegates from the different governments interested, and from the French and foreign railroad managements. The International Association has decided that the railroad congress shall sit at Milan in 1887, and at Paris in 1889. The companies do not see how this meeting can be reconciled, so far as they are concerned, with the programme of the committee.

"Under these conditions the six companies have all, without exception, repeated their refusal to join in the work of the semi-centennial committee."

Water Waste in Cities.

MR. PETER MILNE, ex-Water Purveyor of Brooklyn, recently delivered a very interesting and instructive address to the members of the Oxford Club of that city regarding the water-supply of Brooklyn. He was entirely right in maintaining that the embarrassment of a short supply which constantly meets all growing communities can never be adequately overcome until there is a radical change over the present methods of locating and fitting up water-supply pipes within buildings. The enormous waste which is due to the running of water from open faucets in cold latitudes six months out of the year, because the pipes and fixtures are located where the water is certain to freeze, and the leaking of improperly constructed apparatus twelve months out of the year, is due to the fact that there is no intelligent control of the character of the fittings used and to the way they are fitted up.

As Mr. Milne points out, it might not be practicable to attempt too much interference by municipal authorities in cities like Brooklyn with the details within occupied houses. In such an event the meter is the only resource, for that would in time deter the householder from recklessly wasting water which he knows he will have to pay for. But in all large cities this is hardly enough, since this will only operate to make a householder take care of the apparatus that he may have in use. The root of the matter is the location of plumbing in buildings, which should be controlled by the authorities when new work is being constructed. That is to say, plans should be filed, as required in the case of drainage, and when, in the judgment of competent persons, the location of pipes and fixtures is such as to insure their freezing in the winter months, such plans should be rejected and the plan modified to secure the needed protection. In other words, such care should be taken in the matter as is now exercised by the Health Department of New York and Brooklyn over the running of drain and waste pipes. Until that is done, even though meters are universally used, the householder, often through ignorance and frequently through causes beyond his control, will be compelled to pay for the water he wastes, which waste he would not be obliged to permit if the water-pipes in his building were in the first place properly located with reference to the possibility of freezing. In large cities the occupants of houses in the great majority of cases are only tenants, and, besides not being responsible for the location of pipes and fixtures in the buildings they occupy, would often find it cheaper to pay for water wasted than to incur the expense of remodeling the water-supply system of the buildings they occupy.—*Sanitary Engineer*.

The Berlin City Elevated Railroad.

WHILE there are sections of elevated road or viaduct in the railroad entrances into London and other large European cities, Berlin is the only one which has at present an elevated railroad used for city travel, although the building of an elevated line in Paris is soon to be begun.

The different railroads entering Berlin were united in 1875 by the Ringbahn, or Circuit Railroad, which forms an irregular circle, or rather oval, around the city. This was built by the Government for the purpose of connecting the roads, but it is also used for purposes of suburban traffic, as it passes through a number of villages and small towns.

To supplement this circuit road the Government decided to build a line running directly through the city,

connecting at each end with the Ringbahn, and through it with the various lines running out of the city. This road, which is known as the Stadtbahn, or City Railroad, was completed in 1882; it extends from the station of the Silesian Railroad on the east to that of the Charlottenburg Railroad at the west end of the city, following very nearly the course of the River Spree. At one point, indeed, it is built directly over the bed of that stream, and it crosses on bridges three times.

As in nearly all German Government works the primary object of the Stadtbahn was military, to afford facilities for the passage of troops through the city without transfer, and for massing them readily at any point. At the same time the local traffic was kept in mind, and arrangements made for its accommodation. The road has four tracks for its entire length, two of them being used exclusively for through and suburban trains of the different roads, the other two for the local trains, of which there are two classes, one running over the city road only, the other over the city road and the Ringbahn, or circuit road also.

The total length of the Stadtbahn is 7.55 miles, of which 1.05 miles are simple earth-work embankment; 0.42 mile walled embankment; 1.13 miles iron bridges and viaducts, and 4.95 miles masonry viaduct. The bridges include 65 iron bridges over streets; an iron viaduct over the Humboldstrafen; two iron bridges over the Spree and a masonry bridge over the same river. As already mentioned, at one point, near the Jannowitz Bridge, the masonry viaduct is directly over the bed of the river for a distance of 0.34 mile.

As may be inferred from the description of the road, it does not follow any of the city streets, but is built through the blocks. Where the masonry viaduct is used, the archways are utilized as storehouses and work-shops, very much in the same way as in the approaches to the Brooklyn Bridge in New York. To give access to these, parallel streets have been opened on each side of the road. These parallel streets are not yet all completed, but are being gradually extended.

The width of the road for four tracks is 52½ ft. This is increased at and near the stations, the platforms being placed between the tracks. At the larger stations, as named below, there are two platforms, one for the through and one for the local tracks; at the minor stations there is a platform for the local tracks only.

The stations are two stories high, the lower story, of brick, on a level with the street, containing the ticket office, waiting rooms, etc.; the upper story is of iron, and is an open shed or train-house, covering the platforms. At the larger stations, where through trains stop, there are baggage rooms, and hydraulic elevators are provided for raising the baggage to the platforms. At each station there is a block signal.

The rails used are of steel (56 lbs. per yard) and are supported on longitudinal iron sleepers of the Harmann pattern.

For the through trains no special class of locomotives is used, the engines of the different roads running the trains. For the local trains engines of a pattern very common in Germany are used, having four driving-wheels coupled and two leading wheels. The later engines (somewhat heavier than those first used) have cylinders 14.2 in. diameter and 22.8 in. stroke, and driving-wheels 62.8 in. diameter. The fuel used is coke, from which there is very little smoke. The local trains have special cars built for this service; they are lighter than the ordinary cars and are of second and third class only, no first-class being provided.

The total cost of the Stadtbahn was about $16,212,000, or $2,047,285 per mile. Of the total cost of the road about 40½ per cent. was for land and 59½ per cent. for construction.

Trains are run on the block system, each of the stations having a signal station. Semaphores are used, the signals being transmitted by electricity on the Siemens-Halske system. Two classes of trains, as already noted, pass over the Stadtbahn, the through passenger trains, of which there were at a recent date 112 daily, running at no regular intervals. The local trains run at intervals of 10 minutes during the busier hours of the day, this interval being reduced to 5 minutes on holidays and other special occasions. On ordinary days 280 trains a day are run. The highest speed allowed is 28 miles an hour. No freight trains pass over the Stadtbahn, all exchange of freight cars being made over the Ringbahn. The charge for second-class tickets is about 15 cents for the whole length of the line and 10 cents for shorter distances; for third-class, 10 and 5 cents. Workmen's tickets are issued at a lower rate; they are good only before 8 A. M. or after 4 P. M.

The population of Berlin is not far from that of New York. The city is nearly circular in shape, being thus much less favorable to the development of a single line of travel than New York. Even with allowance for this, however, the people of Berlin do not seem to patronize the elevated road as much as might be expected. The number of local passengers carried for four years has been as follows:

1882	8,524,348
1883 (Exposition year)	10,116,826
1884	9,157,762
1885	10,196,028

The number carried in 1885 was an average of 27,934 per day. The elevated line of lighest traffic in New York last year carried about 25 per cent. more than this; the line of heaviest traffic over 4½ times as many, while the total traffic of the four New York lines was over ten times as great.

The total cost of operating the Stadtbahn in 1885 was about $900,000; the receipts from local traffic were about $800,000. The earnings from the through trains, however, probably exceeded the deficit; they were not given separately, but are included in the general receipts of those lines. It is to be remembered that the road, having been built for military reasons chiefly, has been constructed and operated in a more expensive manner that if it had been a commercial undertaking.

The facts given above are derived chiefly from a pamphlet recently published in Paris by MM. Gaudin and Zuber.

Rope Transmission of Power.

THE *Iron Age* says: "Systems of rope transmission for power purposes have been in use for many years, but it is only quite recently that they have given promise of being more generally recognized as a convenient aud efficient means of accomplishing the ends for which they were designed. The results which have been obtained with them, it is true, have not always been of uniform excellence, mainly, however, because designers have in some cases failed to recognize properly the requirements of good working. Where rope driving has been tried and has failed, examination has almost invariably revealed a disregard of correct principles of construction, and has shown nothing calculated to detract from the favor in which the system is held, especially where a continuous high speed is required. As regards the comparative cost of rope and other systems of gearing, and the average life of a rope of the kind ordinarily used in manufacturing establishments, it is difficult to get any precise data. As compared with leather belting, however, we have seen figures reflecting very favorably on rope transmission, the relative costs having been in the proportion of about eight to one. As to the life of a rope it has been roughly estimated that with proper usage it should not be less than about seven years. Cases where ropes have suddenly broken are, moreover, few in number, the risk in this respect being reduced to a minimum by the fact that any defects in a rope, arising either from wear or other causes, will show themselves long before the point of danger is reached. In mill districts, particularly, engineers have not been slow to avail themselves of these advantages, and with the cotton rope which is there chiefly used, most satisfactory performances are recorded. It is but natural, under these circumstances, that the field of usefulness of rope gearing is gradually being extended—some enthusiastic supporters of the system having even gone so far as to advocate it to the exclusion of almost all other means.

Manufactures.

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THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 185.)

Chapter V.

SMOKE STACKS AND SPARK ARRESTERS.

There is probably no part of a locomotive, unless it be the valve gear, on which so much ingenuity has been exercised as on spark arresters, The very first engines built at the Rogers Works had some kind of bonnet or wire netting on the top of the chimney to "catch the sparks," and, in the article on page 14 reprinted from the *American Railroad Journal*, of December, 1839, it will be seen that at that time an inverted cone was placed on the "axis of the smoke-pipe to protect the wire

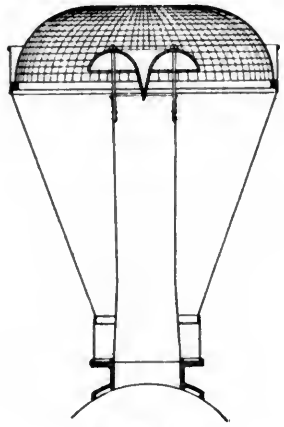


Fig. 109.
1854.—Wood.

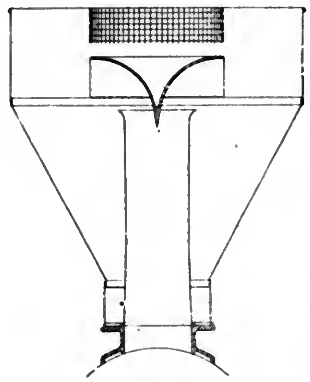


Fig. 110.
1854.—Wood.

gauze." Unfortunately there are no drawings extant of any of these early spark arresters. Figs. 109 to 137, however, give examples of later practice, and show different devices demanded by those who ordered locomotives of the Rogers Works. The date when they were first made and the fuel used is given under each of the figures.

Fig. 109 is what is called a bonnet stack, on account of the bonnet or hood of wire netting over the top. It was used for burning both wood and coal.

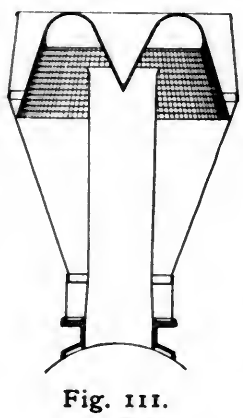


Fig. 111.
1854.—Wood.

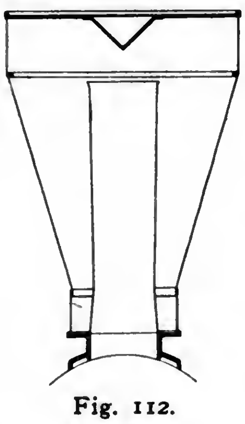


Fig. 112.
1856.—Wood.

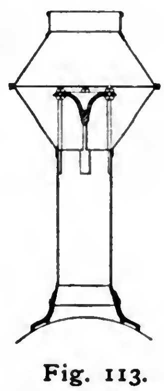


Fig. 113.
1858—Coal and Wood.

Fig. 110 had a deflecting cone and netting in the form of a cylinder over it.

Fig. 111 had a large deflecting cone with wire netting in conical form attached to the lower edge of the deflector.

Fig 112 had a cone with flat horizontal netting of annular form around it.

Fig. 113 is known as the diamond stack, from the form of the outline of its top. It had a deflecting cone, but no netting.

Fig. 114 had a curious shaped deflecting cone and a cast-iron guard at *A A*, to protect the sheet-iron of the outside casing from the action of the cinders. It also had an annular opening, *B B*, around the top, the supposition being that the air coming in contact with the inclined surface *C C*, would be deflected upwards through the opening *B B*, and thus create an induced upward current out of the chimney.

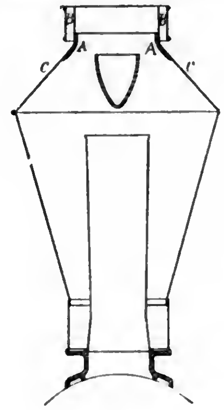


Fig. 114.
1860.—Bituminous Coal.

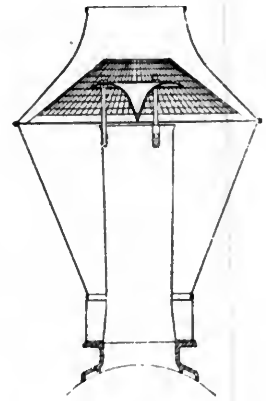


Fig. 115.
1862.—Bituminous Coal.

Fig. 115 had a deflector with a conical netting over it, which was open at the top.

Fig. 116 was the same as Fig. 115, but of different form.

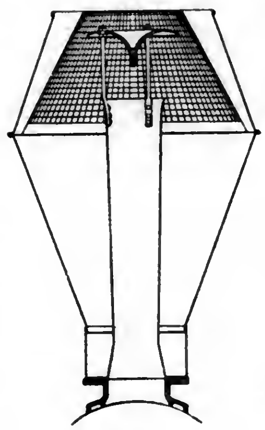


Fig. 116.
1863.—Wood.

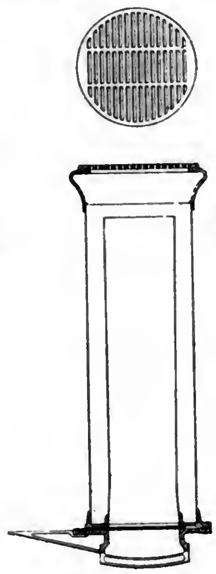


Fig. 117.
1864.—Anthracite Coal.

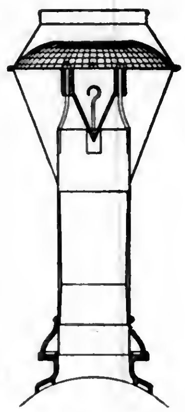


Fig. 118.
1866.—Bitum. Coal.

Fig. 117 is a straight chimney with a cast-iron grate at the top and a sliding damper at the base.

Fig. 118 had a deflector with a netting over it, which was open in the middle. The opening was surrounded by a cylindrical shaped netting, as shown.

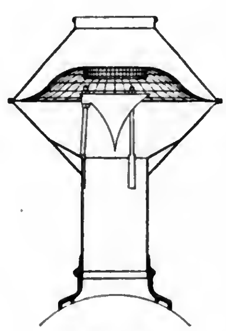


Fig. 119.
1867.—Bituminous Coal.

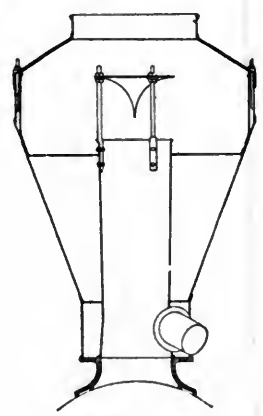


Fig. 120.
1869.—Bituminous Coal.

Fig. 119 was the same as Fig. 110, but of different shape and proportions.

Fig. 120 had a deflector with a very large casing or receptacle for sparks.

In Fig. 121 the netting was placed horizontally over the deflector.

Fig. 122 represents the celebrated Radley & Hunter stack,

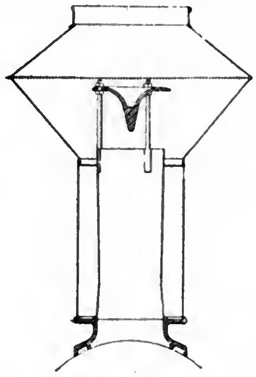


Fig. 121.
1869.—Bituminous Coal.

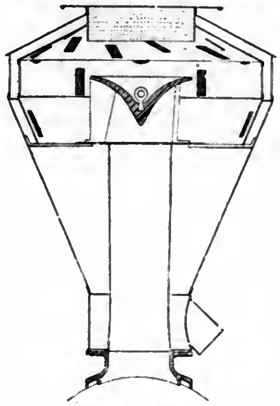


Fig. 122.
1870.—Wood.

which was at one time very generally used for wood-burning locomotives.

Fig. 123 has a conical shaped netting over the deflector, with an opening in the center surrounded by another netting of cylindrical shape.

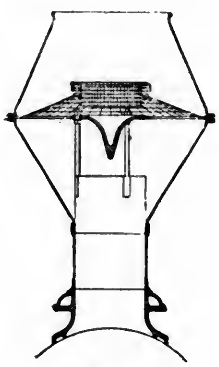


Fig. 123.
1872.—Wood and Coal.

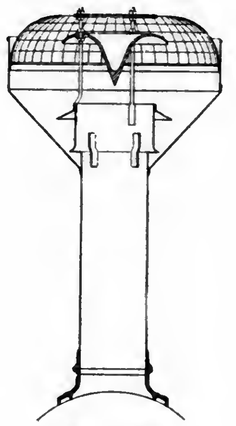


Fig. 124.
1872.—Wood.

Fig. 124 has a deflector with a wire-netting bonnet over it.

Fig. 125 is similar to fig. 124.

Fig. 126 has a deflector with a circular opening above it, and cylindrical guard around the edge made of perforated sheet-iron or copper.

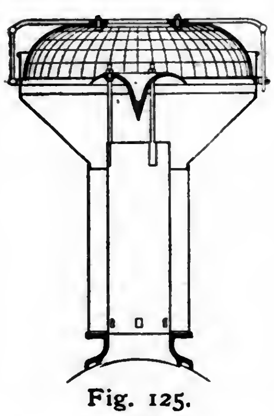


Fig. 125.
1872.—Coal.

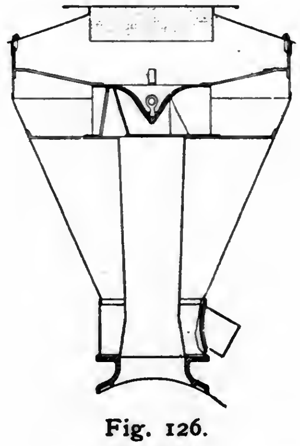


Fig. 126.
1873.—Coal.

Fig. 127 shows what is called a "straight" stack, and has no spark-arresting attachments.

Fig. 128 represents the Fontaine stack. This has a deflector, *D*, to which a shield *S S*, is attached. Between the shield and the outer casing there is space for the passage of the products of combustion, which escape in the direction indicated by the darts.

Figs. 129 had an outside case or receptacle for sparks which was unusually large. It had a deflector surmounted with an inverted cone of wire netting. This forms a guard for the opening at the top so that all the smoke must pass through the netting to escape into the open air.

Fig. 130 shows a stack with a spark arrester patented by

Fig. 127.
1879.—Bituminous Coal.

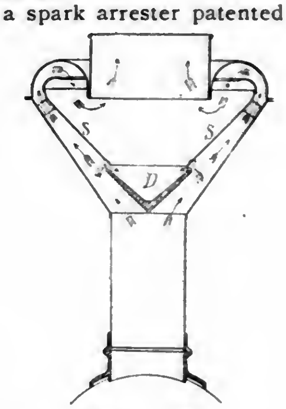


Fig. 128.
1879.—Bituminous Coal.

Wm. S. Hudson in 1877. The reflector is formed of what Mr. Hudson described as "peculiarly curved screw blades," which are shown on plan in the engraving. "The gaseous products of combustion," the inventor says in his specification, "mingled with more or less small masses of coal in various conditions,

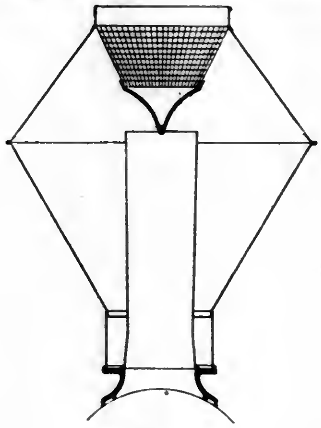


Fig. 129.
1879.—Bituminous Coal.

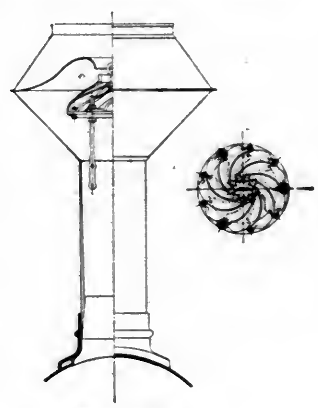


Fig. 130.
1881.—Bituminous Coal.

are thrown violenty upward through the cylindrical chimney, and, striking in the hollow interior of the dome-like set of wings, are thrown into a spiral motion without completely interrupting their upward motion. The solid matter is pro-

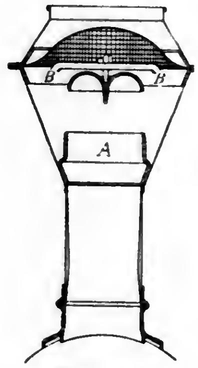


Fig. 131.
1881.—Bituminous Coal.

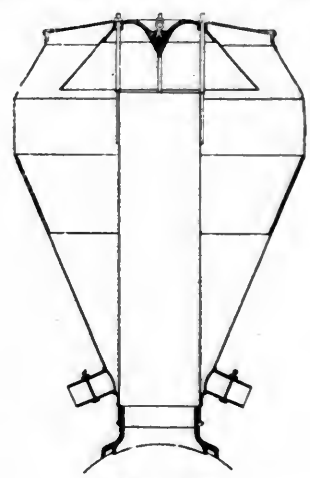


Fig. 132.
1881.—Bituminous Coal.

jected against the wire netting. A portion of the gaseous matter follows the same course, and another portion moves inward, and, passing freely upward through the open space in the center."

Fig. 131 is provided with a casting, *A*, which forms what was

called a stricture, for some purpose not clearly understood. The usual deflector was suspended from a casting, *B B*, with radial arms meeting in the center.

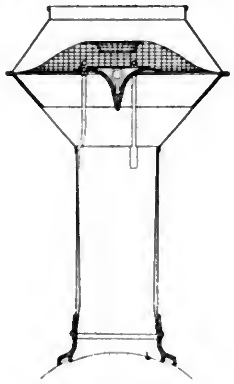


Fig. 133.
1882.—Bituminous Coal.

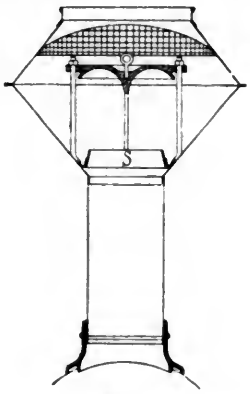


Fig. 134.
1882.—Bituminous Coal.

Fig. 132. This stack had a large receptacle for sparks, with a deflector placed at the top. The latter had a sheet-iron guard

Fig. 135.
1882.—Bitum. Coal.

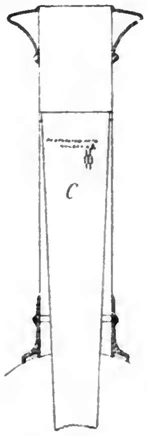


Fig. 136.
1882.—Bitum. Coal.

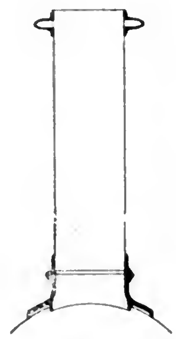
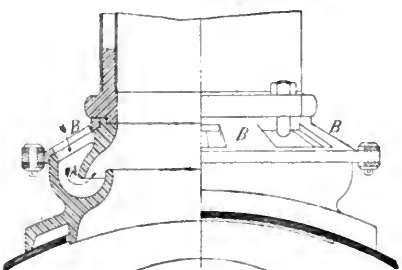


Fig. 137.
1882.—Anthra. Coal.

around the edge, as shown in the engraving. The top of the stack was open; no netting was used.

Fig. 138.



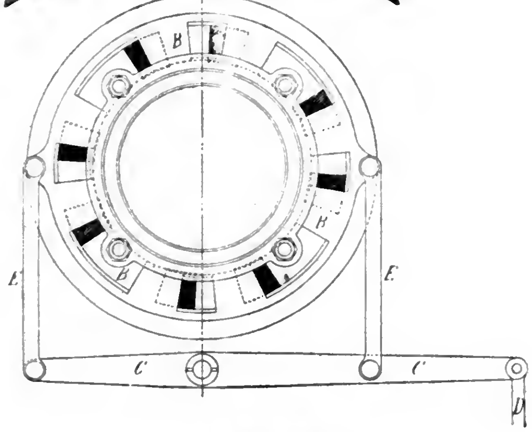


Fig. 139.

Fig. 133 had a deflector with wire netting over it, as shown.

Fig. 134 was similar to fig. 133, but of somewhat different proportions. It also had what was called a "stricture" or contraction of the opening at *S*. The effect of this was to concentrate the escaping current and cause the sparks to impinge directly against the deflector.

Fig. 135 represents what is called a "straight" stack without spark arrester of any kind.

Fig. 136 illustrates a straight stack with a long inverted cone inside of it. This was made of perforated sheet-iron, and was connected at the bottom to the exhaust pipe, so that they discharged inside of the cone and the smoke had to pass through the perforations in the inverted cone. The perforations were $1 \times \frac{3}{32}$ in.

Fig. 137 shows a straight stack for anthracite coal.

CHIMNEY DAMPERS.

Figs. 138 and 139 represent a form of damper recently devised and patented in 1885 by Mr. H. A. Luttgens, who has been the Chief Draftsman in the Rogers Works for 28 years past. It is intended for the chimneys of coal-burning engines. Its object is to diminish the effect of the exhaust by admitting air at the base of the chimney, and thus obviating the necessity for opening the fire-door and admitting cold air into the firebox.

In constructing the damper the base of the chimney is made of the form shown in half section on the left side of fig. 138, from which it will be seen that there are cavities *A*, through which air is admitted, as indicated by the darts. The outer openings of these cavities are shown by the dark shading and dotted lines in the plan, fig. 139. On top of these openings is a circular valve or cover with openings corresponding to those in the base of the chimney. This valve by being turned a part of a revolution by means of the links *E, E*, and lever *C, C*, which is connected with the cab by a rod *D*, will cover or uncover the openings leading to the cavities in the base of the chimneys, and thus air may be admitted to or shut off from the chimney at pleasure.

(*To be continued.*)

Manufacturing Notes.

A NEW nail mill and rolling mill has been built at Watsontown, Pa., and is nearly ready to begin work.

THE Catasauqua Iron Company has bought the plate mill formerly owned by the Abbott Iron Company, of Baltimore, and has removed the plant to Ferndale, Pa., where a new building, 80 x 500 ft. is nearly finished to receive it. The mill will roll boiler plate up to 8 ft. wide.

THE Lehigh Car Company at Stemton, Pa., is to be reorganized. The property is now owned by the Allentown National Bank.

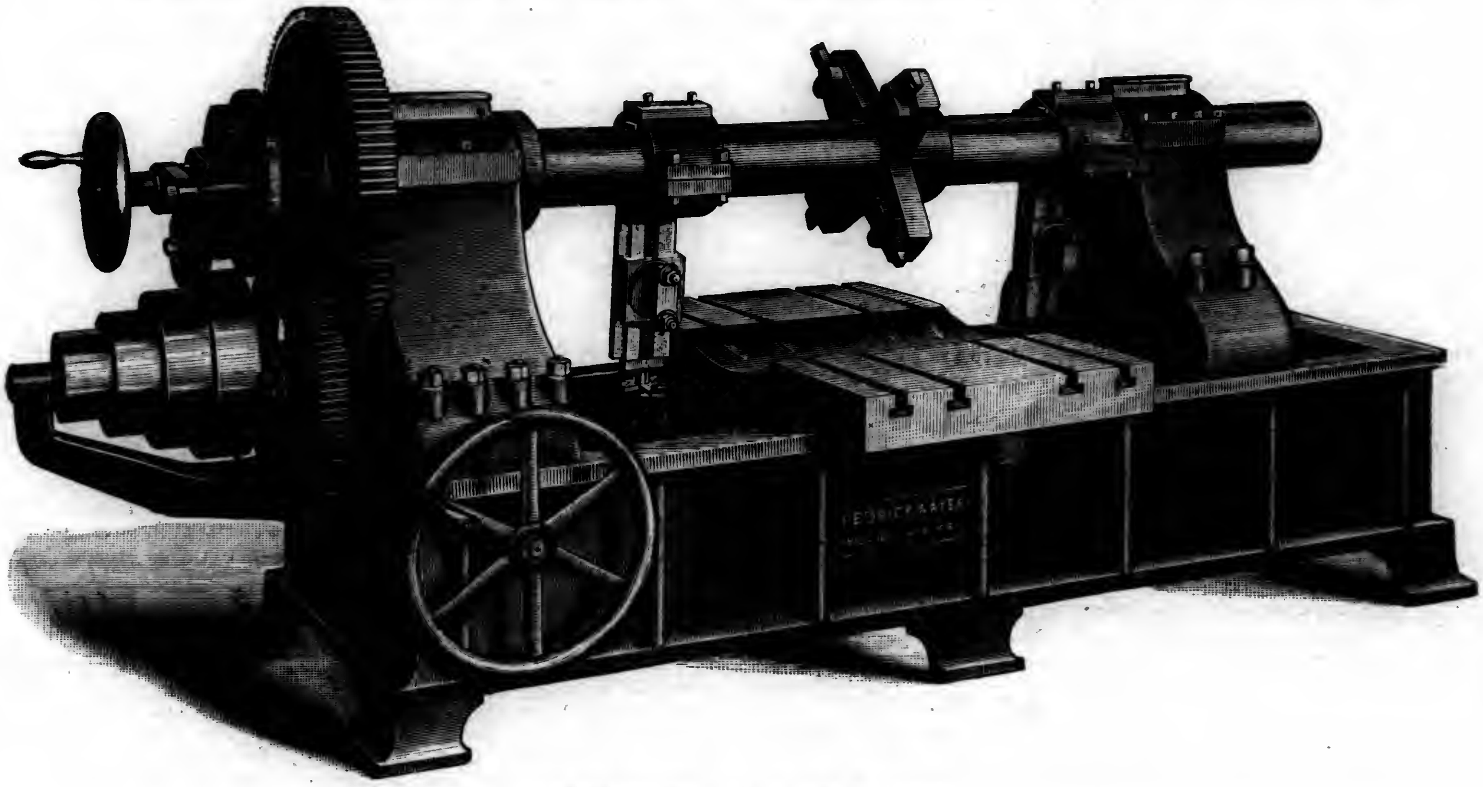
THE new Westinghouse building for the joint offices of the various Westinghouse companies in Pittsburgh is being rapidly pushed. It will be fire-proof throughout. It has a floor plan of 80 x 110 ft. and is 200 ft. in height, with three high-speed passenger elevators. It will be lit throughout with incandescent light and warmed by indirect steam radiation, with natural gas as the fuel. It will be occupied exclusively by the offices of the various Westinghouse companies.

A Nickel Copper Aluminum Alloy.

"LECHESNE," says a French magazine, is an alloy of nickel, copper, and aluminum for the production of a superior kind of German silver. It is recommended as combining absolute malleability with an exceptional degree of homogeneity, tenacity and ductility. The inventor, M. Thirion, claims also for the new metal less liability to oxidize and to act as a heat conductor than other alloys heretofore in use. These latter advantages, he holds, are conspicuous on a comparison of the new alloy with those of nickel and copper for coinage, and with the old-fashioned descriptions of German silver (nickel, copper and zinc), or, again, with the best kind of latten. Like gold, silver, and platina, the "lechesne" alloy satisfies the conditions of the most difficult processes that could be applied, such as hammering, drawing and deep chasing or punching, especially in ornamental work. The distinctive feature of this metal consists in the addition to the binary alloy (nickel and copper) of a quantity of aluminum, calculated according to the proportion of the nickel. The aluminum is introduced a few moments before the casting process, care being taken to send it to the bottom of the fusion, and to ensure thorough distribution throughout the mass by vigorous mixing. Its combination is facilitated by its natural affinity to both copper

and nickel. The proportion of the aluminum entering into the alloy is as follows: 165 centigrammes per kilogramme of alloy containing 10 per cent. of nickel. Any attempt to deoxidize an alloy of nickel and copper in which the aluminum was not carefully introduced toward the close of the fusion would lead to carbureting. If it was sought, for instance, to expel the surplus carbon by superheating, the inadequate quantity of free oxygen present would prevent the combustion of the carbon, so that the metal would in reality become even more deteriorated by the process by an increased oxidation. The aluminum both deoxidizes and decarburets the metal, but the following precautions should be observed: The nickel is first placed in the crucible, and as soon as it melts the copper is gradually introduced, the vessel, of course, being closed. When the two metals are in a state of fusion they are puddled together, then the alloy is reheated and the aluminum thrown in, the temperture being rapidly raised almost to a boiling point. In the next place, the alloy is cast very hot, this operation being effected promptly and with the utmost regularity. The chief malleableness of the article is derived from the copper, which imparts a property and a tone in that respect found lacking in the nickel. The aluminum suddenly, but surely, oxidizes the alloy, burning away every trace of carbon introduced into the crucible.

New Cylinder Boring and Facing Machine.



CYLINDER BORING AND FACING MACHINE.

THIS machine, the general construction of which is well shown by the accompanying illustration, is intended for heavy work. It is, accordingly, built very heavy and is powerfully geared. The size shown will bore cylinders from 10 in. to 25 in. diameter; other sizes are built also.

The bar is solid forged steel, with steel screw and bronze thrust-bearings. The feed-casing is made to feed either way and has two changes, to operate which it is only necessary to push in or pull out a pin in the center of the hand-wheel. The facing head can be placed on the bar quickly, and in any place desired, and, if necessary, can be operated at the same time the cylinder is being bored. The bed is movable on the shears, and is easily set in position by the hand-wheel at the forward end of the machine. The cutter-heads have a long bearing on the bar, and are arranged for four tools, that number being found by experience to be the most desirable, as it distributes the stress or strain on the bar, and four times the metal can be removed.

These machines are made at the L. B. Flanders Machine Works of Messrs. Pedrick & Ayer, in Philadelphia.

Proceedings of Societies.

Engineers' Club of Kansas City.

A REGULAR meeting was held April 4, at which several gentlemen were proposed as members.

Mr. William D. Jenkins read a paper on Compressed Air as applied to the Construction of Foundations. This was illustrated by drawings and photographs of the new bridge now under construction over the Missouri at Randolph.

Engineer's Club of St. Louis.

A REGULAR meeting was held in St. Louis, April 6, Vice-President Holman in the chair; 28 members and 4 visitors present. The commitee on resolutions on the death of Capt. Jas. B. Eads asked for further time to prepare a report, which extension was granted.

S. Bent Russell then read a paper on Draining and Filling Water Mains, describing the system of operations in use in this city, where shut-offs average one per day. The difficulties met with and the precautions to be taken were duly treated upon. In the discussion Mr. Holman gave some interesting points in his experience, bearing on this question.

Prof. C. M. Woodward opened a discussion on the failure of the Bussey Bridge on the Boston & Providence Railroad, describing fully the nature of the accident and illustrating the details by sketches on the blackboard. His explanation of the cause of the accident was full and clear. The matter was also discussed by Messrs. Seddon, Frith, Johnson and Moore.

Prof. Johnson announced that there would be a meeting of the board of managers of the Association of Engineering Societies at Chicago at an early date, and asked that suggestions as to the management of the Association be made. Several topics were brought forward and discussed. The club then adjourned.

Military Service Institution.

AT the meeting held at Governor's Island, April 14, Lieuten-E. L. Zalinski read a paper on his pneumatic gun for throwing dynamite shells. After referring to the improvements made, and especially to the increase of air pressure, Lieutenant Zalinski said:

"I have repeatedly denied the statement that the gun is of my invention. I have, however, given direction to its develop-

ment as a practical military appliance. I am not a mechanical engineer, and could not have worked out the mechanical details unassisted. This has been done by Mr. Nat. W. Pratt, of the Babcock & Wilcox Company, Mechanical Engineer of the Dynamite Gun Company, Mr. George W. Reynolds and Mr. Charles Emory.

"With a percussion cap in front a shell in exploding failed to produce any marked effect. It was assumed that the gases envolved by the explosion of the layers in front tended to throw back the gases evolved afterward—a certain amount of time being required to explode the entire charge. This was the point that led to the invention of the electrical fuse. It is so devised and arranged in the shell that the circuit is closed by means of a sensitive plunger an instant before the body of the projectile has struck the target. Indeed the latest projectiles containing large charges, have two or more batteries, so as to explode the charge at several points immediately. The solution of problem resulted in a primer which, in striking the target, explodes the charge an instant before impact; if a ship be missed, explosion follows an instant after the projectile enters the water; failing in this the explosion follows on the projectile reaching bottom; and fourth there is certainty of the circuit remaining open until the projectile leaves the gun.

"I have pushed this work as quickly as I could, because, aside from the professional interest involved, I saw in it possibilities of usefulness in cases of public emergencies which may arise even now, before a regular modern armament could be provided. While I have never considered it all-sufficient for defensive purposes, I have thought it a very valuable auxiliary in any event, but most of all if we were attacked before modern guns, ships and forts are provided, we could, at least, seriously injure any attacking force before being ourselves destroyed."

A discussion followed in which several members took part. The opinion was expressed that rifling the gun would not be possible, on account of the danger of a premature explosion from the oscillation of the projectile due to the rifling.

Master Car-Builders' Brake Committee.

MR. G. W. RHODES, Chairman of the M. C. B. Brake Committee, has issued the following notice:

"Up to date the following brake companies have notified the committee they have made arrangements for cars and engines and will be present at the Burlington Brake tests commencing May 9, next.

"Eames Vacuum Brake Company, Boston, Mass.,
"Carpenter Brake Company, Berlin, Germany.,
"Westinghouse Air Brake Company, Pittsburgh, Pa.,
"Card Electric Brake Company, Cincinnati, O.,
"American Brake Company, St. Louis, Mo.,
"Hanscom Brake Company, San Francisco, Cal.,

"The Parke Electric Brake Company, of Chicago, Ill., and the Rote Brake Company, of Mansfield, O., have their brakes ready but have not yet succeeded in arranging for cars. The committee will not debar them or any other company from the tests, providing they get their cars to Burlington by May 9, 1887."

New England Railroad Club.

THE regular monthly meeting of this club was held in Boston, April 13, President Lauder in the chair.

The regular subject–the Lighting of Passenger Cars–was taken up.

Ex-Governor Howard, representing the Pintsch Lighting Company, explained that system of gas lighting at some length. He said the actual cost is about $12 per car per year, exclusive of cost of fitting up the cars and the plant for furnishing. Including those items, the cost is not over $40 per car per year. He expressed his belief that, where there is a 300° test required of oil used in cars, there is not a railroad but violates the law.

Mr. Adams and Mr. Curtis both took exception to the latter statement, claiming that frequent tests made by the State Inspector demonstrated that the oils were up to the test.

Mr. Coney explained that he had had large experience in manufacturing kerosene, and he very much doubted if the oil used would stand the 300° test when made by the best instruments. He declared he did not believe any accident ever occurred with oil having a fire test of 150°.

President Lauder said he hoped the railroads and the public would not lose their heads because of recent accidents. He thought the present system was a good one, and plenty of light can be obtained, if enough lamps are put in, though the more lamps put in the more heat is generated. He knew of no instance where cars had been set on fire by the lamps, as a very slight shock invariably puts the light out. He thought the heavy expense of lighting with electricity would prevent its general use at present.

Mr. Fowler spoke of the trouble in not taking care of the lamps properly, and said that sometimes the brakemen do not turn up the wicks high enough to show the flame.

Gen. Elbert Wheeler, Treasurer of the Wheeler Reflector Company, stated that, with proper reflectors, he could give the same amount of light with 12 electric lamps as is given by the 20 in the Boston & Albany cars.

Mr. Marden (Fitchburg Railroad) said that he had put in one car five lamps with the Acme burner, and he believed that the car is the best lighted of any running out of Boston, with, perhaps, the exception of the Boston & Albany's electric lighted cars. He believed, however, in electric lights, and is fitting up a car which is to be lighted by storage batteries furnished by the American Accumulator Company. Outside of the work being done by him, the entire expense of fitting up the car, including the accumulators, is only $375. He is putting in 12 lamps.

It was announced that the subject for the next meeting would be Axle-bearings, Dust-guards and Lubricators.

Messrs. Lauder, Marden and Ford were appointed a committee to arrange for transportation to the Master Car-Builders' Convention at Minneapolis in June.

Engineers' Club of Philadelphia.

A REGULAR meeting was held in Philadelphia, March 19, President T. M. Cheman in the chair; 32 members and 3 visitors present.

The Secretary presented, for Mr. Wilfred Lewis, a note upon Phosphor Bronze Wire for Helical Springs.

Mr. John L. Gill, Jr., presented a paper on Screw Threads, in which he argued against the system of screw threads now in general use.

Mr. H. H. Sintzenich, introduced by Mr. Henry G. Morris, exhibited and described a Rail Chair which he had devised with a view of overcoming the objections to joints bolted through the webs of the rails, and of obviating the necessity for brace or check-blocks on curves. The lack of continuity and consequent wear of rail ends, and the constant loosening of nuts, were noted as the principal objections to present forms of rail unions.

The invention consists of two pieces of cast-iron, one of which bears against one side of the web of the rail, and is held to the tie by three ⅝-in. coach screws, 6 in. long, while the other piece abuts against the first and against the other side of the web of rail, forming a clutch which is held in place by a single screw located about 4 in. from the rail. Mr. Sintzenich stated that these chairs have been used continuously, for two winters and one summer, on the Intercolonial Railway at Moncton, N. B., that these screws had not once loosened, and that no other objection to the joint had been discovered.

The Secretary presented, for Mr. F. H. Lewis, a paper upon Clapp-Griffiths Steel for Structural Work.

He describes the method of manufacture as compared with the Bessemer process and the adaptability of the required plant to mills with a small output, and gives the results of very full physical tests of specimens, with a few chemical analyses. Test specimens were exhibited.

In conclusion he says: "Some tests of full-sized eye-bars of this metal have been made with generally favorable results; about three-fourths of the bars, it is said, being satisfactory. I have not been able to get the figures. Altogether, the showing, as regards quality of material, is good, and the evidence of a considerable period of time and a large number of tests seems to be conclusive that the specifications for mild structural steel can be readily filled by the Clapp-Griffiths metal with a percentage of rejection certainly under 5.

"As regards the question of whether the steel is better than Bessemer or not, as has been claimed, I can only say that any one who sees his way clear to argue that question is welcome to the floor."

Mr. Percival Roberts, Jr., followed with some discussion, questioning whether any advance in steel manufacture could be claimed for this process.

The Secretary presented, for Mr. Emile Low, a paper on Maps for Railroad Surveys. In this Mr. Low recommends the use of separate sheets, 19 × 24 in., which, on the scale of 200 ft. to 1 in., which he prefers, would each include about one mile of the road. The convenience of handling and filing these sheets, as compared with large drawings, would be very great. They could also be conveniently carried in the field; for this purpose Mr. Low showed a convenient portfolio,

which could also be used as a drawing-board. He gave various systems of arrangements of continuous sheets with reference to the meridian, convenience in tracing from two or more sheets, and other points.

A REGULAR meeting was held in Philadelphia, April 2, President T. M. Cleeman in the chair; 32 members and 5 visitors present. The following were elected active members of the Club: Messrs. Conway H. Day, Lino F. Rondinella, Henry S. Prichard, Eugene A. Rhoads, A. Wells Robinson, George N. Bell, Joseph Powell, Jr., and Griffith W. Jones.

The Secretary presented, for Mr. Theo. Low, Notes on Railroad Construction. The paper treats of detail in the management of surveys and plans, forms of note books, methods of accurate measures for bridge work, coffer-dams, etc. It embodies many excellent suggestions as to practical details.

Mr. F. W. Whiting, introduced by Mr. L. C. Madeira, Jr., presented a paper upon the Prevention of the Spreading of Fires, treating especially of the relation of the proper and scientific design and construction of buildings to their safety from entire destruction in case of the starting of a fire within them.

Mr. Francis Lightfoot, introduced by Mr. J. Kay Little, exhibited and described a Stamp Splice, Tongue and Groove Rail Joint, devised by him. The ends of the rails are stamped, at the heat at which they leave the last roll, into such shape that they will halve over or against each other, and sustain each other by an arrangement of tongues and grooves. They are simply bolted together without any additional plate or fixture. They have been laid on a portion of the Pennsylvania Railroad, where they are being subjected to severe test. The inventor claims that the test, to date, has been entirely successful, and that many advantages have been obtained over other forms of joint.

Mr. Max Livingston presented a paper on Petroleum, in which, after reviewing the history of its production in America, he gave an account of the Russian oil fields.

The Secretary presented a communication from Mr. Gratz Mordecai, suggesting an active interest on the part of the Club in local engineering matters and public work. It was referred to the Board of Directors.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, on the evening of April 6.

The Committee on the 24-hour System reported that the question of the adoption ot that systen would be taken up by the General Time Convention.

It was announced that Harry Gilbert Darwin had been elected a Fellow of the Society.

The following elections were announced: *Members:* Horace Andrews, City Engineer and Surveyor, Albany, N. Y.; Frank Graef Darlington, Superintendent Cincinnati & Muskingum Valley, Zanesville, O.; Joseph Thompson Dodge, Chief Engineer Montana Central, Helena, Mont.; Edward Adolph Hermann, Assistant Engineer Cincinnati, Indianapolis, St. Louis & Chicago, Indianapolis, Ind.; Henry Clay Jennings, Assistant Engineer, Chicago, Milwaukee & St. Paul, Milwaukee, Wis.; Samuel Fisher Morris, Assistant Engineer, New Croton Aqueduct, Yonkers, N. Y.; Benjamin Franklin Thomas, U. S. Assistant Engineer in charge Big Sandy River, Louisa, Ky. *Juniors:* George McGrew Farley, Engineer Maintenance of Way Northwestern Ohio Railroad, Toledo, O.; Gideon Frederick Haynes, Advisory Engineer mills of William Roberts, Waltham, Mass.

The subject for the evening—the discussion of Mr. Wm. Metcalf's paper on Steel—was then taken up.

Lieutenant Jacques, U. S. N., read a written discussion in which, while speaking in the highest terms of Mr. Metcalf as an expert, he dissented from his views on certain points. The offer of the Bethlehem Works, to make the steel required under the recent competition, he considered a guarantee that the system of building up steel guns is the best. He considered the Terre Noire experiments as also proving that a steel gun cannot be cast successfully. He asked Mr. Metcalf why, if hammering and rolling were not beneficial, he resorted to these processes so universally in his own shops.

To this Mr. Metcalf replied that they were called upon for about 6,000 sizes and different shapes, and hammering and rolling were the most economical methods for producing them. He did not believe there were any beneficial effects resulting.

Dr. R. J. Gatling then read a written discussion, in which he held that hard steel was not a safe material for guns. He advocated the use of mild steel, and believed that large guns could be cast successfully. He continued at some length, upholding Mr. Metcalf's views, that gun-steel should not be hammered, pointing out the dangers from overheating and overannealing, etc.

Mr. F. Collingwood read a brief paper expressing the opinion that, when experts such as Mr. Metcalf expressed so positive an opinion respecting the possibility of casting large guns successfully on the Rodman plan, it was un-American for us to blindly follow the lead of other nations without first following the lead of our *own* traditions, and proving the truth or falsity of Mr. Metcalf's position by actual test.

Mr. A. H. Emery said that while he had given the subject of guns and projectiles very considerable attention, his greater experience was in the behavior of the materials which would enter into them. He acknowledged the good work of the Rodman cast-iron gun, but pointed out that the conditions had changed very much in the last 20 years, in weight of charge and projectile, muzzle velocity and initial pressure on the gun. He thought, moreover, that there was an element of safety and strength in the old cast-iron gun that was lacking in mild steel. Thus, while cast-iron had a low limit of elasticity, it would bear very high compressive strains and transmit such strains without flow of metal. Mild steel, on the other hand, met the limit of resistance to this flow at 40,000 lbs. pressure, and pressures of more than 30,000 lbs. were now applied to guns, with a rapid tendency to increase this pressure in practice. The speaker illustrated this theory by describing some experiments at the Watertown Arsenal, where the wax test was applied to two similar cylinders, one wholly of cast-iron and the other having a portion of the cast-iron replaced by a lining, $\frac{3}{16}$ in. thick, of wrought-iron; the latter burst first, though it would seem to have had in it the stronger combination of metals. The explanation was that the wrought-iron commenced to flow under the pressure applied and assisted the wax in bursting the outer shell of cast-iron instead of strengthening it. Mr. Emery described the process of drawing down steel bars by machine hammering and testified to the good qualities of this steel, and for his ideal gun only asked for a piece of metal of similar quality 4 ft. square and about 40 ft. long. But he did not expect to live long enough to see such a mass made equal in quality to the smaller sections first referred to. He thought, therefore, to insure the best material and perfect homogeneousness, we must depend upon built-up guns made from comparatively small parts. He referred to the good work done by exceptionally hard steel 6 in. pins used in his testing machine, which have stood for years the severest shocks and strains, such as would result from the breaking of a test-bar, with 750,000 lbs. stress upon it, recoiling against this pin over a $\frac{3}{4}$-in. space.

Mr. J. M. Knapp believed in making a full trial of the cast-steel gun before going further in the construction of heavy guns.

Mr. Dorsey spoke of the Armstrong wire-wound gun and the results obtained from it.

Mr. Theodore Cooper said that his experience had taught him to prefer mild steel for structural purposes on account of its greater reliability. He believed that large guns could be successfully made of cast-steel, and that they would be superior to the best built-up guns. The speaker, in discussing the bursting effect in guns, called attention to the interesting arrangement of the lines of flow, or stress lines, in passing from the bore to the exterior of the gun barrel; the author had already addressed the Society on this subject in a paper on the effect of punching steel, and the same lines had been afterward noticed by a Russian engineer. These curved lines cross each other at an angle of about 45°, and are so well defined under stress, that they can be etched and printed from.

Prof. De Volson Wood spoke briefly of the relative action of a bursting charge on solid and built-up cylinders.

A lengthy paper, by Mr. John Coffin, was partly read, which was largely illustrated by diagrams, treating mainly on the condition of carbon in steel, as modified by working. The reading was not completed, owing to the lateness of the hour.

Besides the papers already mentioned, written discussions were presented (but not read) by Commander C. F. Goodrich, Prof. John W. Langly, Lieutenant Commander F. M. Barber, Lieutenants Arthur M. Knight and R. R. Ingersoll, Messrs. Henry M. Howe, D. L. Whittemore, Wm. Sellers, M. J. Becker, L. L. Buck, W. H. Burr, A. Gottlieb, A. E. Hunt, C. A. Marshall, P. Roberts, Jr., Joseph M. Wilson and S. T. Wagner. No subject before the Society for a long time has called out such a discussion.

Mr. Metcalf, being called on to close the discussion, expressed disappointment that it had gone so much in the direction of gun manufacture. He referred to other parts of the discussion not yet read, showing variations in carbon utterly

disproving the conclusions reached by Mr. Coffin. His interest does not lie in gun manufacture, but in the use of steel structurally. He had pointed out four or five fundamental facts as a result of the manufacture of steel and testing it during 20 years, and he presented them for the use of the profession and an advance in the intelligent use of the material by engineers. He cautioned them against accepting refinements as to carbides, carbon of cementation, etc. With regard to steel guns, he thought that it was very important to remember the susceptibility of the metal to changes under the influence of heat, and asked a careful consideration of the subject.

AT the meeting of April 20, the Secretary announced that the Committee had decided to hold the annual meeting at the Hotel Kaaterskill in the Catskill Mountains, in the first week of July. There would be a steamboat trip up the Hudson, an inspection of the work on the Poughkeepsie Bridge and other excursions; details to be announced hereafter.

The discussion of Mr. Metcalf's paper on Steel was then taken up again. The Secretary read abstracts of the written discussions including those of Mr. E. J. Whittemore, who referred to the loss of strength by steel in passing through shop manipulations.

Commander C. F. Goodrich favored a trial of cast-steel guns.

Lieutenant Commander Barber also believed that cast-steel guns should be tried, although somewhat doubtful of their success on account of the difficulty of making the castings. He noted that nearly all the important improvements in guns adopted in Europe were of American origin.

Lieutenant R. R. Ingersoll asked about the effect of annealing on cast-steel guns.

Lieutenant Austin M. Knight referred to the very small proportion of failure in built-up guns. The effect of vibrations resulting from the explosion of gunpowder is still almost unknown.

Mr. Wm. Sellers wrote of the difficulty of securing good castings for very large guns.

Mr Charles A. Marshall said that there was much risk with large castings, while built-up guns could be tested in every part.

Mr. Henry M. Howe believed in a trial of cast guns.

Mr. A. E. Hunt spoke of the difference in quality of steel and the importance of annealing. His paper was accompanied by elaborate tables of tests made of gun steel.

Mr. John Coffin presented a summary of experiments made by Mr. J. A. Grinnell.

Professor J. W. Langley approved Mr. Metcalf's statement that steel is a fluid.

Mr. M. J. Becker referred to the increasing tendency to use cast-steel for certain parts of bridges.

Professor W. H. Burr gave some results of recent experiments. He does not believe in cast-steel for guns.

Mr. A. Gottlieb wrote of the treacherous nature of steel and the need of careful forging.

Mr. S. F. Wagner thought greater care was needed in tests; also in heating steel.

Mr. Joseph M. Wilson said that engineers could get such steel as they needed; also mentioned some results of over-annealing in eye-bars for bridges.

Mr. Percival Roberts, Jr., thought that structural steel should be tested in completed form. Chemical tests were also to be regarded.

Mr. Buck wrote of the bursting strains on guns and proposed a cast gun with an interval tube of hard steel for the bore.

After the reading of the papers there was a verbal discussion, joined in by Messrs. Worthen, Cooper, Roberts, Collingwood, Brinkerhoff and others.

Master Car-Builders' Club.

THE regular monthly meeting was held in New York, April 21, President C. E. Garey in the chair.

The subject of Lighting Cars being taken up, Mr. Dixon explained the the well-known Pintsch system of lighting by gas.

Ventilation of Cars being next in order, the Ober ventilator was shown. Mr. Creamer made a few remaks on his own and other systems.

Heating Cars was then brought up, and Mr. W. T. Taggart, of the Standard Car Heating & Ventilating Company of Pittsburgh, explained the Westinghouse heater, which is a steam heater, the boiler being suspended under the car.

Mr. Bell then spoke of the Bell Safety Casing, which is a boiler-iron box or case placed over any form of heater, and secured to the car, with provision for automatically closing the door in case of accident.

Mr. M. B. Rooney then described the Hurley System of pipes and couplings, which can be used for either steam or hot air.

Mr. Frank M. Wilder stated that he had devised a system of heating, which would soon be ready for trial.

Mr. Martin spoke of the extending use of the Martin Anti-fire System. Mr. Frost gave an exhibition of his plan for extinguishing fire in case of accident.

General Time Convention.

AT the spring meeting held in New York, April 13, this body, which has of late years extended its functions considerably beyond its original duty of arranging schedules for through trains, considered and adopted the uniform train rules, provisionally adopted at the previous meeting. A code of uniform telegraphic rules was also considered.

A report was received on the 24-hour system of reckoning time, accompanied by documents from the American Society of Civil Engineers. This subject was laid over, many of the members favoring the system, but believing that time would be required to secure its adoption.

The Committee on Uniform Car Mileage Reports presented a report giving answers obtained from a number of lines. This Committee recommended: 1. That a record should be kept of all cars switched to connecting lines, and junction reports sent daily. 2. That mileage of line cars should be reported to owning companies or line managers as companies may direct. 3. That the charge for passenger cars on foreign roads be 3 cents, postal 2 and baggage cars 1½ cents per mile. This report was approved.

Association of Railroad Superintendents.

THE half-yearly meeting was held in New York, April 12.

The Committee on Uniform Rates for Trains using other Roads in Emergencies made a report, which was discussed.

The Committee on Frogs made no report, but there was a discussion on the subject.

The Committee on Freight Car Demurrage reported, recommending a charge of $1 per day for detention, 72 hours being allowed for unloading, loading, etc. This was discussed and finally approved.

The Committee on Machinery was instructed to confer with the Master Mechanics' and the Master Car-Builders' Associations, and the Committee on Roadway with the Roadmasters' Association.

There were short discussions on Car Couplers; on Track Inspection; on Yard Signals; on Train Dispatching; on the Prevention of Fire from Locomotive Cinders; on Steam Heating of Cars; on Lighting Cars and on the use of Fire Extinguishers in case of accident.

The following officers were chosen for the ensuing year: President, H. F. Royce, Chicago, Rock Island & Pacific; First Vice-President, C. S. Gadsden, Charleston & Savannah; Second Vice-President, L. W. Palmer, New York & New England; Third Vice-President. J. B. Morford, Michigan Central; Secretary, Waterman Stone, Providence, Warren & Bristol; Assistant Secretary, C. A. Hammond, Boston, Revere Beach & Lynn; Treasurer, R. M. Sully, Richmond & Petersburg.

Standing Committees were appointed as follows: Executive, W. H. Murphy, H. Stanley Goodwin, A. B. Atwater; Machinery, R. G. Fleming, J. F. Divine, C. S. Gadsden; Roadway, Messrs. Howard, Holbrook and Law; Transportation, Messrs. Blee, Metheany and Chase.

Master Car-Builders' Association.

THE following circulars have been issued from the Secretary's office, under date of April 15:

ANNUAL CONVENTION.

The Twenty-first Annual Convention will be held in Minneapolis, Minn., beginning on Tuesday, June 14, at 10 A. M. The following is a list of the subjects on which it is expected that special reports will be made, and which will be discussed during the sessions of the Convention:

1. Standards and Appliances for the Safety of Trainmen.
2. British and Continental Practice in Matters of Interest to the Master Car-Builders' Association.
3. Automatic Freight Car Brakes.
4. The Comparative Advantages of the Two Methods of

constructing Freight Cars, with and without Platform Timbers or End Sills projecting from the End of the Car.

5. Maximum Outside Dimensions of Freight Cars.

6. Standard Draw-Gear for Non-Automatic Couplers.

7. Appliances to Prevent the Slipping of Wheels, both Passenger and Freight

8. Standard Freight-Car Truck and Axle for Cars of 60,000 bs. Capacit y.

9. Standard Sizes of Lumber for Freight Cars.

10. The Best Form and Construction of Car Roofs.

The revision of the Rules Governing the Condition of, and Repairs to, Freight Cars for the Interchange of Traffic, will be the special order of business at 3 o'clock P. M. on the second day (Wednesday, June 15) of the session of the Convention. In order to take part in this revision, representatives of railroad companies must be members of the Association.

The Constitution provides that: "Any person holding the position of Superintendent of the Car Department, Master Car-Builder or Foreman of a Railroad Car Shop, or one representative from each Car Manufacturing Company, or other Company owning over 1,000 cars which are not in process of purchase by other parties, may become an Active Member by paying his dues for one year. Unless expelled from the Association, his membership shall continue until his written resigna- is received by the Secretary.

"Any person having a practical knowledge of car construction may become a Representative Member by receiving a *written* appointment from the President, General Manager or General Superintendent of any railroad company, to represent its interests in the Association; provided that no Repregentative Member shall represent more than one railroad or system of roads under one General Manager or General Superintendent. Such members shall have all the privileges of an Active Member, including one vote on all questions, and, in addition thereto, shall, on all measures pertaining to the adoption of standards or the expenditure of money, have one more vote for each full 1,000 cars which are owned, or which are in use and in process of purchase, by the road or system which he represents. His membership shall continue until notice is given the Association of his withdrawal or of the appointment of his successor. No railroads or system of roads, under one General Manager or General Superintendent, shall have more than one Representative Member. In the enumeration of four, six, eight or more wheeled cars, four axles to count as one car.

"SEC. 1. Every member will be subject to the payment of annual dues, to be assessed at each annual meeting, to defray the necessary expenses of the Association, provided that no assessment shall exceed $8. Each Representative Member shall pay, in addition to his own dues so assessed, the same amount for each additional vote to which he is enitled."

Blank applications for active membership and blank appointments for representative membership will be forwarded on application therefor to the Secretary. It is desirable that such applications and appointments should be filled out and forwarded to the Secretary before the annual convention is held, although persons may become members during its sessions.

Arrangements have been made with the management of the West Hotel in Minneapolis for the accommodation of the members of the Association, with board and room for $2.50 per day for each person; rooms with bath attached, $3 per day for each person. These rates are for members *only*. The Committee of Arrangements were unable to secure the same rates for those who will attend the meetings of the Association, but who are not members of it.

The manager of the hotel tenders all its accommodations to the members, but he says it will be impossible to give rooms to single persons or so large a number unless many of them will room together. A blank application for rooms is enclosed herewith. Members who wish to engage rooms are requested to fill out the names, on the enclosed card, of those persons who will room together, and then forward it to the manager of the West Hotel.

Representative members are requested to report to the Secretary, either before or at the Convention, the number of cars owned by their companies.

BEST FORM AND CONSTRUCTION OF CAR ROOFS.

YOUR Committee to report on the best form of Car Roof, at the Annual Convention to be held June, 1887, would respectfully ask your assistance in making up their report by giving them facts as you may have referring to Car Roofs, particularly as to the name, plan of construction, material and amount used, cost of labor and material average life, and any other information bearing on the subject that you may deem valuable.

They would kindly remind you that the value and importance of their report will depend largely upon your assistance in this way.

They will be pleased to receive your reply if possible not later than May 15, 1887, addressed to the Chairman, J. D. McIlwain, Grand Trunk Railway, London, Ontario.

J. D. MCILWAIN.
L. PACKARD. } Committee.
S. IRVIN.

SECRETARY'S OFFICE.

Communications for the Secretary of the Association should hereafter be addressed to him at No. 45 Broadway (instead of 23 Murray street), New York.

Association of Engineering Societies.

A MEETING of the board of managers was held in Chicago, April 15, Mr. Benezette Williams presiding; J. B. Johnson acting as Secretary. The Engineering Societies of Boston, Chicago, St. Louis and St. Paul were represented.

After discussion it was ordered that the proposition submitted by Secretary Prout for the printing of the *Journal* of the Association, be accepted, provided that the number of surplus copies of each issue, over and above all takers, shall be at least 50 per cent. of the number taken in the Association, and that the remainder of these, on the termination of this contract, shall become the property of the board of managers, and provided that the publication shall appear, as heretofore, as published by this board, and provided that no article shall be allowed to appear in any periodical before the circulation of the copies of the *Journal* which contain said article.

The application of the Engineers' Club of Kansas City to become a member of the Association was granted, this making seven societies now in the Association.

Chairman Williams and Secretary Prout were unanimously reëlected to their respective offices. It was ordered that the Index Department remain under the general control of Mr. Johnson, as heretofore.

A committee appointed to prepare an address to the societies in the Association presented an address showing the advantages secured by union, and urging upon the seven societies now represented and others which may join them the formation of a National Union. It is suggested that a convention be called, to which all engineering societies be invited to send representatives.

This report was adopted, and the Chairman was authorized to send the address to all the societies, and to make arrangements for the convention when responses are received.

It was ordered that official documents of the Council of Engigineering Societies upon National Public Works be published in the *Journal*. After authorizing the usual assessments, the board adjourned.

PERSONALS.

Mr. W. Crosby has been appointed Engineer in charge of the Asylum Street improvement in Hartford, Conn.

Mr. William K. Lyon has been appointed Superintendent of the Housatonic Railroad, in place of H. A. Bishop.

Mr. Harvey Sawyer is Chief Engineer of the Chesapeake & Nashville road, with office at Gallatin, Tennessee.

Mr. J. E. Capps is appointed Master Car-Builder of the Mobile & Ohio Railroad, with office at Whistler, Ala.

Mr. Reuben R. Marble has been appointed City Engineer of Columbus, O., in place of John Graham, resigned.

Mr. William Alfred Kellond is appointed Assistant to the General Manager of the Louisville & Nashville Railroad.

Mr. O. H. Dorrance has resigned his position as Superintendent of the Nebraska Division of the Union Pacific road.

Mr. E. A. Flewellen has resigned his position as Chief Engineer and General Manager of the Columbus & Western Railroad.

Messrs. Charles Kellogg and **Thomas C. Clarke** have withdrawn from the partnership known as the Union Bridge Company.

Mr. W. W. Fagan has been appointed General Superintendent of the Kansas City, Fort Scott & Gulf and the Kansas City, Springfield & Memphis roads. He has bee time Superintendent of the Central Branch, Union Pacific.

Mr. T. G. Dabney has been appointed Chief Engineer of the Memphis, Arkansas & Texas, a projected new line in Arkansas.

Mr. W. L. Richards, of Aberdeen, Dak., is Chief Engineer of the projected Aberdeen, Bismarck & Northwestern Railroad in Dakota.

Mr. Jason Rogers has been appointed a member of the Illinois Railroad and Warehouse Commission in place of W. T. Johnson.

Mr. M. J. Rogers has been appointed Master Mechanic of the Chicago, Santa Fe & California road, with office at Streator, Ill.

Mr. W. I. Allen is appointed General Superintendent of the Chicago, Kansas & Nebraska road, with headquarters at Horton, Kansas.

Mr. N. C. Ray, recently on the Union Pacific, has been appointed Resident Engineer at Butte, Mon., on the Montana Central Railroad.

General James B. Hill has been appointed Railroad Commissioner of Virginia in place of Mr. H. G. Moffet, whose term has expired.

Mr. John J. Martin has been appointed Chief Engineer of the Pine Bluff, Monroe & New Orleans Railroad, with office at Pine Bluff, Ark.

Mr. H. H. Rogers has been chosen President of the Troy Iron & Steel Company, of Troy, N. Y., in place of Chester Griswold, resigned.

Mr. Spencer Smith, of Council Bluffs, has been appointed Railroad Commissioner of Iowa in place of Judge McDill, whose term has expired.

Mr. W. B. Doddridge is appointed Superintendent of the Central Branch, Union Pacific, in place of W. W. Fagan, resigned to go to another road.

Mr. W. H. Stevenson has been appointed General Manager of the Honsatonic Railroad. He was recently on the New York, New Haven & Hartford road.

Lieutenant Commander Henry E. Nichols, U. S. N., has been ordered on duty as inspector of steel for the new cruisers, under charge of Commander Evans.

Lieutenant William B. Caperton, U. S. N., has been ordered to duty as inspector of steel at Pittsburgh, under general direction of Commander Evans.

Mr. W. D. Ballentine has been appointed Master of Machinery of the Florida Railway & Navigation Company, succeeding Mr. L. S. Randolph, resigned.

Mr. D. J. Lucas has been appointed Engineer in charge of construction of the St. Louis & Chicago road. He was recently Engineer of the East Penn Oil & Gas Company.

Mr. E. F. Fuller, of New York, is Chief Engineer of the Paducah & Illinois Bridge Company, which proposes building a bridge at Paducah, Ky., across the Ohio River.

Mr. Edward Barrington, of Washington, D. C., has been appointed Chief Engineer of the Kansas City, Superior & Northwestern Railroad, a projected line in Nebraska.

Mr. T. J. Potter, Vice-President of the Chicago, Burlington & Quincy, has resigned that office to accept the position of First Vice-President of the Union Pacific Company.

Lieutenant Colonel Peter C. Hains, U. S. Engineers, is assigned to duty in charge of the construction of the bridge over the Eastern Branch of the Potomac at Washington.

Captain Smith S. Leach, U. S. Engineers, has been assigned to duty as Secretary and Disbursing Officer of the Mississippi River Commission, with headquarters in St Louis.

Mr. T. S. Dunn, heretofore Roadmaster of the Pensacola Division of the Louisville & Nashville road, has been appointed Roadmaster of the Mobile & Montgomery Division also.

Mr. T. J. Frazier Assistant Engineer, Trans-Ohio divisions, Baltimore & Ohio, will, in addition to his other duties, take charge of maintenance of way, Chicago Division, from April 1.

Colonel R. S. Miner has been appointed Superintendent of the South & North Alabama Division of the Louisville & Nashville road in place of Mr. Levi Hege, transferred to another position.

Mr. George A. Kimball has resigned his office as City Engineer of Somerville, Mass. Mr. Kimball is in practice as consulting engineer, making a specialty of water supply and sewerage.

Mr. F. Y. Dabney has been appointed Chief Engineer and General Manager of the Columbus & Western Railroad, with office at Columbus, Ga. He succeeds Mr. E. A. Flewellen, who has resigned.

Mr. L. W. Towne has resigned his position as General Superintendent of the Kansas City, Fort Scott & Gulf and the Kansas City, Springfield & Memphis roads on account of continued ill health.

Captain W. W. Peabody has been appointed General Manager of all the Trans-Ohio lines of the Baltimore & Ohio, with office in Chicago. He was recently President of the Ohio & Mississippi.

Mr. L. S. Randolph has been appointed Master Mechanic of the Cumberland & Pennsylvania Railroad, with office at Mt. Savage, Md. He was recently with the Florida Railway & Navigation Company.

Mr. C. A. Swineford has resigned his position as Superintendent of the Madison Division of the Chicago & Northwestern road and will go to Alaska, where he intends to occupy himself in gold mining.

Mr. William G. Raoul, late President ot the Central Railroad Company of Georgia, is to be President of the Mexican National Railroad Company. Mr. Raoul is now in Mexico, inspecting the line of the road.

General John McNulta, of Bloomington, Ill., has been appointed Receiver of the Wabash lines east of the Mississippi in place of Judge T. M. Cooley, now Chairman of the Interstate Commerce Commission.

Mr. George D. Harris, for six years past Master Mechanic of the Richmond & Allegheny Road, has resigned that office and has accepted the position of Superintendent of Motive Power of the Mobile & Ohio Railroad.

Mr. Levi Hege has boen appointed General Roadmaster of the Louisville & Nashville Railroad, with office in Louisville, Ky. He has been for some time Superintendent of the South & North Alabama Division of the road.

Mr. Howard Carlton, Assistant Master Car-Builder of the Baltimore & Ohio, with headquarters at Newark, O., has resigned to accept the position of General Manager of the South Baltimore Car Works, dating from April 1.

Commodore Thomas P. McCann has been appointed commandant of the Boston Navy Yard in place of Rear Admiral Lewis P. Kimberly, relieved. Commodore McCann has been for some time on the Lighthouse Board.

Mr. Stacey B. Opdyke has been appointed Assistant Engineer of the New York, New Haven & Hartford Railroad, with office in New Haven, Conn. He was recently Superintendent of the New Haven & Northampton road.

Mr. James C. Clarke, President of the Illinois Central Railroad Company, recently tendered his resignation on account of ill health. The Directors would not accept it, and granted Mr. Clarke six months' leave of absence.

Rear Admiral Lewis P. Kimberly, (having been promoted from the rank of Commodore) has been relieved from duty as Commandant of the Boston Navy Yard and ordered to take command of the South Pacific Squadron.

Mr. William E. Rogers has been nominated by Governor Hill as Railroad Commissioner of New York, a previous nomination having been withdrawn. Mr. Rogers has just completed one term of four years; he is a civil engineer by profession.

Mr. W. T. Small has been appointed Superintendent of Motive Power, Machinery and Rolling Stock of the Northern Pacific Railroad, with office in St. Paul, Minn., in place of G. W. Cushing, resigned. Mr. Small has been Mr. Cushing's assistant for some time past.

Mr. W. A. Scott has been appointed Superintendent of the Madison Division of the Chicago & Northwestern road in place of C. A. Swineford, resigned. Mr. Scott has been for some time Assistant Superintendent of Motive Power of the road; he is President of the Western Railway Club.

Mr. Isaac V. Baker, Jr., has been nominated by Governor Hill as a member of the New York Railroad Commission, a previous nomination having been withdrawn. Mr. Baker has been for some time State Prison Superintendent; he was at one time with the Delaware & Hudson Canal Company.

Mr. Edward A. Moseley, of Newburyport, Mass., has been appointed Secretary of the Interstate Commerce Commission. Mr. Moseley is a member of the Boston lumber firm of Stetson, Moseley & Co., and was last year president of the Mechanics' Exchange of Boston. He is at present a member of the Massachusetts Legislature.

Mr. Reuben Wells has been offered and has accepted the position of Superintendent of the Rogers Locomotive &

Machine works at Paterson, N. J. Mr. Wells was for a number of years on the Jeffersonville, Madison & Indianapolis road, and for several years has been on the Louisville & Nashville as Superintendent of Motive Power. He has always been an active member of the Master Mechanics' Association. Mr. Wells is in every way well qualified for his new position.

Mr. George W. Cushing has resigned his position as Superintendent of Motive Power, Machinery and Rolling Stock of the Northern Pacific Railroad. Mr. Cushing has had wide experience in his department, and stands high in the estimation of his superior officers and his many friends throughout the country. In accepting his resignation, Vice-President Oakes says: "Mr. Cushing's long and successful service with this company, his ripe experience and good judgment, the present efficiency of his department, as well as other considerations, personal and official, render the necessity of accepting his resignation one of extreme regret. He will carry with him the esteem of his official associates, attended with the earnest hope that the success enjoyed here will crown his efforts in any new field he may enter.

NOTES AND NEWS.

Harrisburg Electric Railroad.—A street railroad 3½ miles in length is to be built from Harrisburg to Steelton, Pa. It is to be an electric road on the Van Depoele system, like the line now in operation in Scranton.

Electric Railroad at Derby, Conn.—A company has been organized to build an electric railroad from Derby, Conn., to Birmingham and Ansonia. The road will be built on the Van Depoele system, and will be 3½ miles long.

New Steel Ferry-Boats.—The Columbia Iron Works & Dry Dock Co., of Baltimore, is building two steel ferry-boats for the Staten Island Rapid Transit Company. These boats will be 236 ft. long, and will have all the latest improvements.

American Engines Abroad.—The Westinghouse Machine Company has recently received orders for two engines, 35 and 150 H. P., for a rolling mill in Moscow, Russia; two of 25 and 60 H. P., for Yokohama, Japan, and one of 150 H. P., for a mining company in Australia.

Iron Imports into Russia.—An alternative scheme for gradually abolishing the importation of iron into Russia has been submitted to the Imperial Council. It proposes either to gradually prohibit the imports of iron, or gradually increase the duties until they become prohibitory.

Geological Surveys in the Southwest.—In Arkansas and Texas laws have recently been passed providing for State geological surveys. A similar measure is urged for Missouri. In that State a survey was ordered about 40 years ago, but was never completed, and the work done was of very poor quality.

The New Naval Observatory.—Congress has made an appropiation of $100,000 for the erection of a new naval observatory near Washington. The entire cost is limited to $400,000. Mr. Hunt, of New York, has been selected by the Secretary of the Navy as architect, and is now preparing the plans.

Canals in Bengal.—There are now in the province of Bengal, India, in actual operation, 783 miles of canal. Most of these canals were built for irrigating purposes, but 553 miles are navigable, and were used last year by no less than 241,951 boats and rafts. The total area of land irrigated from the canals last year was 455,987 acres.

A Large Coasting Vessel.—The four-masted schooner *T. A. Lambert* recently sailed from Bath, Me., on her first voyage. The *Lambert* is said to be the largest vessel of her class ever built. She is 247 ft. long, 46 ft. beam and 22 ft. depth of hold; the registered tonnage is 1,620, and the carrying capacity 2,700 tons of coal. The vessel will carry coal from Baltimore to Boston.

Abandoning a Canal.—The Philadelphia & Reading Railroad Company, which leases and works the Schuylkill Canal, has decided to abandon the use of the canal altogether, claiming that coal can be carried more cheaply by rail. The bondholders of the canal will, however, foreclose their mortgage, and announce that they will keep the canal open after they secure control.

Allen Paper Car Wheel Company.—On April 1 the general offices of this company were removed from New York to Chicago. The company retains a branch office in New York, which is, from May 1, at Nos. 31 and 33 Broadway, and is in charge of the Vice-President, Mr. J. C. Beach. This New York office will also be the headquarters of Mr. L. F. Tracy, Eastern agent of the company.

Scranton Electric Railroad.—The Scranton Suburban street railroad, which is an electric road built by the Van Depoele Electric Manufacturing Company, was opened November 1 last. Under the contract, it was operated by the builders until April 1. At that time, its working having proved satisfactory in all respects, it was formally accepted by the company. It is proposed to build an extension of the line.

Belgian Iron and Steel Production.—The pig iron made in Belgium in 1886 was 697,110 tons, a slight decrease from 1885. The total output of manufactured iron last year was 470,022 tons. The steel made was: Cast-steel (ingots, etc.), 139,215; forged steel (rails, plates, etc.), 129,418; total, 268,633 tons.

The coal mined in Belgium last year was 17,253,144 tons.

The Naval Ordnance Shops.—Plans for the ordnance shops at the Washington Navy Yard have been prepared by the board of officers and submitted to the Secretary of the Navy.

By these plans the shops will, in a short time, be ready to handle guns up to 6-in. bore, but it will require two years to procure the necessary plant for handling and fitting very large guns.

Union Bridge Company.—The partnership heretofore existing under the title of the Union Bridge Company expired by limitation on March 1, last. At the same time a new partnership, under the old name, was formed by C. S. Maurice, George S. Field, Charles Macdonald and Edmund Hayes. These gentlemen were all in the old firm. Messrs. Charles Kellogg and Thomas C. Clarke, of the old firm, do not join in the new one.

Car Heating and Lighting.—The Boston & Albany Company now has a train running on the New York–Boston through line which is heated by steam from the locomotive, the Martin anti-fire heating system being used. This train is lighted by electricity, the Julien storage battery system being used.

The Fitchburg Railroad Company has equipped a train with the Sewall system of heating by steam from the locomotive. This train is now in regular service.

Russian Locomotive Works.—The Russian Government has sanctioned an increase to the capital of the Kolomna Locomotive Works of $750,000, to be expended in adding to the plant and developing the resources of the establishment. It was recently stated that large orders for locomotives had been given to the works for locomotives for the South and Southeast Russian railways. The head of the establishment is General Struve, the eminent shipbuilder.

Car Lamp Patent Suit Ended.—The patent suit brought a number of years ago by Messrs. Hicks & Smith against the Chicago, Milwaukee & St. Paul Railroad Company, the Dayton Manufacturing Company and others for alleged infringement of the Hicks & Smith patents on car lamps, has finally been dismissed. A satisfactory settlement of the controversy has been agreed upon and a license has been given to the Dayton Manufacturing Company to use the Hicks & Smith patents.

Proposed Mining Tunnel.—It is proposed to build a mining tunnel or adit to drain the gold mines at Nevada City and Grass Valley, Cal., which yield a steady amount of moderately rich ore, but have now reached a depth at which the cost of pumping is heavy. The tunnel will be about 12 miles long and will enter the mines at from 1,200 to 1,300 ft. below the surface. In building the tunnel, it is proposed to use compressed air, the compressors to be worked by the water power of the Yuba River.

Block Signals on the Erie.—The Union Switch & Signal Company has taken a contract to equip the Eastern Division of the New York, Lake Erie & Western road with a system of block signals and interlocking switches. The system will extend from Jersey City to Turners, miles, and in that distance there will be 27 towers or signal stations and 10 points at which there will be a complete system of interlocking switches. The work will cost about $60,000, and will be finished in June.

"Gabarets."—The *National Car-Builder* says: "The Pittsburgh, Cincinnati & St. Louis Railroad is noted for the convenience and ingenuity of its 'gabarets.' Superintendent of Motive Power Wall invented the name and helped Engineer Harrington to design the article. It is used for measuring the height and breadth of cars and their loads. When Mr. Harrington first received orders to make a drawing of a gabaret, he thought the thing was connected in some way with jaw, and he was not very far out."

Locomotive for Suburban Service.—The Rhode Island Locomotive Works in Providence recently delivered to the

Boston & Providence road a locomotive of the Forney pattern, intended for service on the suburban trains out of Boston. The engine has 17×24 in. cylinders and four drivers 56½ in. diameter. The boiler is 48 in. diameter of barrel and has 156 tubes 10 ft. 6½ in. long. The weight is 112,400 lbs., of which 63,700 lbs. are on the drivers, and 40,700 lbs. on the truck. The truck, under the tank, has six Krupp steel wheels.

Pennsylvania Railroad Improvements.—The Pennsylvania Railroad Company is making many improvements at Harrisburg, Pa. The main line is to be changed to the old canal bed, thus avoiding a number of street crossings. The freight yard is to be enlarged so that freight trains will not have to use the passenger tracks. The foundations have been laid for a new passenger station.

The length of sidings at many points between Harrisburg and Altoona is to be increased and some new sidings built.

Blast Furnace for Cuban Ore.—The Pennsylvania Steel Company has bought a tract of 600 acres of land at Sparrow's Point, nine miles from Baltimore. This tract has a fine water front and will be connected with the Northern Central Railroad by spur tracks. At this place the Company will build two blast furnaces for the purpose of making pig-iron from the ores brought from the mines at Juragua, Cuba, which are owned jointly by this company and the Bethlehem Iron Company. The ore will be delivered from vessels, and the pig-iron will be shipped directly to Steelton by rail.

Sandberg's Goliath Rails.—The *Journal de Liége* mentions that recently Messrs. Cockerill commenced to roll Mr. Sandberg's "Goliath" steel rails of 50 kilos. per meter, or 100 lbs. per yard, for the Belgian State Railways. The rails are rolled from ingots weighing nearly a ton, making two rails of nearly 30 ft. in length. The fastenings and joints proposed by M. Flamache are being made at the same train of rolls. Tests are being made to prove the strength of the rails, some of which are to be put down at once on the trunk lines between Liége and Verviers, and the Plateaux de Herve line.

A New Steam Engine.—Herr Wilhelm Schmidt, of Braunschweig, is the inventor of a new type of steam engine, working with very high steam pressure. The steam, before being admitted to the cylinder, is reduced in pressure and increased in volume by means of an injector where the steam from the boiler mixes with a portion of the exhaust steam. An experimental engine of some 40 H. P. has been at work for some time, with satisfactory results, and a marine engine on this principle is now being built by Messrs. Blohm & Voss, in Hamburg, who have the exclusive licence for this system as applied to marine engines.

Electric Train Signals.—The Judkins electric train signal, which is in use on several New England roads, has heretofore derived its power from a battery carried on the train. A new plan is to be used hereafter, a compact little dynamo run by a small engine, which takes steam from the locomotive boiler. The arrangement is so very compact that the engine and dynamo together take up a space only 8 in. long, 6 in. wide, and 10 in. high. It is to be placed in the cab. As only 10 lbs. pressure is required to run the engine, the amount of steam required will be very small. Trains on the Old Colony Railroad are to be equipped with this device.

Iron Making in New England.—The Gosnold Mills. at New Bedford, Mass., have closed down permanently. They have been in operation since 1856 in the manufacture of rolled iron, chains and small cut nails, The Boston *Herald* says that "the directors have made up their minds that it is of no use for New England, where the fuel to work a ton of iron costs $4, to attempt to compete with districts where natural gas costs only 60 cents in the manufacture of staple iron goods. The machinery will probably be disposed of where it can be used to advantage, and the buildings, which are not adapted to any other purpose, will be taken down."

New Vessels for the Navy.—The Secretary of the Navy has advertised for proposals for building five new vessels for the Navy. They are the *Newark*, the appropriation for which was increased by the act of March 3, '87, from $1,100,000 to $1,300,000, the two 4,000-ton crisers to have a speed of 19 knots, and the two gunboats of the type of gunboat No. 1, authorized by the same act. The plans and specifications for the *Newark* are about complete. Those for the two gunboats are nearly ready, but those for the two cruisers are in a less advanced condition. The advertisement states that they will be ready by June 1.

Transparency of Molten Iron.—Mr. Wm. Ramsay writes to the London *Chemical News* as follows: "Some days ago I was present when a casting was made involving the pouring of several tons of molten cast-iron. The stream was very regular, and resembled a great waterfall. It was possible to see objects through the molten metal, which appeared to be of a yellowish color, but tolerably transparent. Two gentlemen who were present were also convinced of the transparency of the metal. May I ask, through your columns, the opinion of those who have frequent opportunities of being present during the operation of casting, regarding this seeming transparency."

Wear of Rails in India.—*Indian Engineering* says: "We are informed that the 42-lbs. steel rail on the South Indian meter-gauge line are so badly worn as to need very extensive renewals, and are to be replaced by rails of 50 lbs. The 42-lbs. rails are only 10 years old. On the other hand, there has been practically no wear in the 75-lbs. steel rails used on the Madras broad-gauge line, although some of them are 15 and 20 years old. In connection with this subject we may observe that *speed* must be an element in the wear of rails when it exceeds say 15 miles an hour; but it is a mistake to suppose that a line with steep gradients can be worked as economically in this respect as a level one."

Wooden Outlet Sewer.—Mr. Horace Loomis, Engineer of Sewers, New York City, is now building at Pier 29, East River, an outlet sewer of creosoted yellow pine. The sewer is circular, 4 ft. in diameter and 541 ft. long. The staves are 4 inches thick, placed radially, and are secured by galvanized iron hoops 3 × ⅜ in., tightened by two bolts passing through shoulders on the semi-hoops. The hoops are spaced about 4 ft. apart, and the sections of the sewer butt squarely, the joint being covered by an 8 × ⅜ in. hoop. This sewer is supported upon caps bolted to the piles of the wharf previously in place, the joints of abutting sections being made to rest upon these caps.—*Engineering News.*

A New Fuel.—Mr. Sahlstrom, of the Normal Company, Aberdeen (Scotland), has, after a long series of experiments, discovered a new fuel, which is said to be an efficient and economical substitute for coal, as regards steam boiler furnaces. The basis of the new fuel is pitch oil, which is used in combination with superheated steam. The invention has been in practical use at the Normal Company's works for some time, and although the boiler furnace was not specially constructed for the new fuel, satisfactory results have been obtained, a saving of nearly 30 per cent. in the cost of fuel having been effected. We purpose giving in an early issue further details of this fuel, and the method of working adopted.

South American Geography.—The French Hydrographical office has published a map of the Cape Horn Archipelags and the Beagle Channel, from the surveys made by the steamer *La Romanche* during the years 1882 and 1883, when a polar station, according to the international plan, was established in Orange Bay. The map contains many important corrections of the coast line.

The Instituto Geographico Argentino has issued the first sheets of the *Atlas de la Republica Argentina*, edited by Dr. A. Seelstrang. The basis of the atlas and the surveys of the land office, the railroads and the boundary commissions. It will consist of 30 sheets, each province being represented on a scale of 1 : 1,000,000.—*Science.*

Photographing the Sky.—*Science* says: "Ensign Winterhalter, of the U. S. Naval Observatory, has sailed for Paris to represent the Observatory at the conference called by Admiral Mouchez, Director of the Paris Observatory, for the purpose of forming a plan of co-operation in photographing the whole sky. The proposition is to enlist 10 or 12 observatories in the undertaking, and to obtain instruments of uniform power, so that their work may be homogeneous. If the suggestion that each plate shall be four degrees square be adopted, about 11,000 plates will be required; and, with an average of 100 plates per year from 11 observatories, it will take 10 years to complete the map. It is understood that Dr. Peters, of Clinton, N. Y., and Mr. Rutherford, of New York, will also attend the conference."

Baltimore & Ohio Technical School.—The success of the plan for giving technical instruction to the apprentices of the Mt. Clare shops of the Baltimore & Ohio Railroad has been so encouraging, that the directors of the company, at a recent meeting, authorized the establishment of a permanent technical school in connection with the Mt. Clare works. The organization of this school is to be such "as will, on a permanent and well-considered plan afford those entering its service a liberal education in mechanics, engineering, drawing, chemistry and the applied sciences, and give the service the benefit of scientific research and invention as applied to railroad matters."

For the support of the school the directors voted $25,000 for the current year, and fixed $20,000 yearly as the regular appropriation hereafter.

Sugar for Boiler Incrustations.—According to M. Polto, the weekly addition of about 4½ lbs. of sugar to the feed water of a tubular boiler with 126 tubes prevented the formation of incrustations and even detached old deposits from the tubes, when, before the sugar was used, the boiler had to be cleaned out after 45 days of work. The *Chemiker Zeitung*, which publishes this statement, says, however, that it should be noted that sugar, at a temperature corresponding to a pressure of four or five atmospheres, gives place rapidly to the formation of acids, especially formic acid, and that these acids will corrode the boiler shell rapidly. It will therefore be necessary to be careful in the introduction of sugar for the purpose of preventing incrustation, and to make further investigations before admitting its value for this purpose.

An Old Forge.—The *Bulletin* of the American Iron and Steel Association says: "Martic Forge, on Pequea Creek, near the village of Colemanville, in Lancaster County, Pa., has at last been abandoned. Mr. Robert S. Potts, surviving partner of the firm of Davies & Potts, which owned the forge for many years, died in June, 1886, at a good old age, and the forge has since been idle. The property is for sale, but there is no expectation that iron will ever again be made at Martic with a tilt-hammer. The forge is one of the oldest in the country, having been built in 1755. Negro slaves were employed from the beginning in hammering iron at this forge, and it is a curious fact that negroes continued to be the principal workmen down to its abandonment last year. A long row of stone houses is still occupied by them."

Car Heating by Steam.—A trip was recently made over the Maine Central Railroad with a train of 12 cars heated on the Sewall plan. This is the longest train yet tried on that system, and the trip was very successful. Although the day was cold and windy, the cars were kept at 70° to 80,° and no difficulty was found with the engine.

The Pennsylvania Railroad Company has been for some time trying a system of steam heating on a local train on the New York Division. The results have been so good that, it is stated, the use of this system will be extended.

All the trains on the Providence, Warren & Bristol road are to be equipped with the Gold system of steam heating. Mr. Waterman Stone, Superintendant of the road, had one train equipped with the Gold system some time ago, and has found its operation very satisfactory.

Accidents to Employes in Massachusetts.—The Massachusetts Commission report for 1886, says, of the accidents on the railroads of the State: "Of the 274 casualties to employés, 63 were fatal and 211 not fatal; 213 were trainmen and 61 were employed in other capacities. By coupling or uncoupling cars, 2 were killed and 105 were injured. Only one accident is reported as occurring where an automatic coupler was used. In that case a damaged United States coupler connected with an ordinary link and-pin drawbar. Two trainmen were killed and 6 were injured by overhead bridges. Train accidents killed 8 and injured 18. The most fatal class of accidents to trainmen is falling from trains in motion, 17 persons having been killed and 38 injured in this way, most of them severely. By various other accidents 34 were fatally, and 44 not fatally, injured."

Railroad Accidents in Connecticut.—The report of the Connecticut Railroad Commissioner for 1886 gives the number of persons killed and injured during the year on the railroads of the State as follows:

	Killed.	Injured.
Passengers	5	37
Employés	25	142
At highway crossings	9	5
Trespassers	55	47
Total	94	231

Of the 167 employés killed or hurt 60 received their injuries in coupling cars, 27 by falling from trains, and the remaining 80 were hurt in various other ways.

Nearly all of the persons classed as trespassers were killed or injured while walking on the tracks.

Iron Ore in the Bottom of a Lake.—Something new in the way of exploration has been tried during the past winter at the Cleveland mine, at Ishpeming, Mich. The extreme cold formed 2½ feet of ice on the surface of Lake Angeline, when a diamond drill was taken out upon it and several holes bored in the bottom of the lake, which resulted in finding an extension of the Lake Superior hematite running along on its north shore. The lake is surrounded on all sides but the west by high precipitous bluffs of diorite and mixed ores. Along its south shore is the Lake Angeline Mine; very near the northwest end is the Superior Hematite Mine, and the basin of the lake was always supposed to contain large quantities of iron ore. The drill holes now put down show that supposition to be correct. Probably no one ever before took a diamond drill on the ice to explore the bottom of a lake.

Bridges in Indian.—*Indian Engineering* says: "This year will be marked by engineers in India as the 'great bridge year.' Of the many important bridges now under construction and approaching completion the following are noteworthy as showing the magnitude of such work in India: a bridge over the Sutlej, on the Ferozepore Railroad, with 27 spans of 150 ft. each; one over the Jumna at Kalpee, on the Indian Midland Railroad, with 10 spans of 200 ft. each; one over the Jhelum, on the Sind-Sarya Railroad, with 17 spans of 250 ft. each; one over the Gunduck, to connect the Tirhoot system with the Bengal & Northwestern Railroad, with 8 spans of 250 ft. each; one over the Ganges at Benares, on the Oudh-Rohilkund Railroad, with 7 spans of 356 ft. and 9 spans of 115 ft. each; and another over the same river at Balawala, with 11 spans of 256 ft. each; another is that over the Indus at Sukkur now waiting the arrival of the iron-work for a span of 790 ft."

Baltimore & Ohio Employes' Relief Association.—Payments in this Association for February were:

	Number.	Amount.
Accidental deaths	11	$11,500
Accidental injuries	271	3,512
Natural deaths	8	4,300
Natural sickness	471	7,008
Physicians' bills	265	1,233
Total	1 026	$27,553

The total payments from May 1, 1880, to February 28, 1887, were $1,332,748.

The following elections are announced: Members of Committee of Management, A. J. Cromwell, Arthur Sinsel, E. L. Weisgerber, F. H. Britton, Thomas Griffin. Trustees Savings Fund and Building Feature, Thomas Fitzgerald, E. L. Weisgerber.

A Convict Dynamo.—The *Electrical World* says: "The utilization of prison labor as a motive force in connection with the electric light has been much talked about of late, in England, and it is generally admitted by political economists there that criminals might be better employed than in grinding the wind. A great deal of power which could be turned to excellent account is undoubtedly wasted, and the use of the crank as a mere punishment in many London jails has often been condemned. The main objection to prison labor as a motive force seems to be that it is intermittent in character. But, then, it is urged that relays of prisoners might be arranged for and a continuous supply of force secured. There are three shifts in 24 hours in many collieries, and always two; there are three watches on board ship, and the advocates of the system contend that some such plan might be brought into operation with a view to secure a continuous motive power for the production of electricity and many other purposes."

Crossing Accidents in Massachusetts.—The Massachusetts Commission report for 1886 says: "At grade crossings, with gates or flagmen for the protection of travellers on the highway, there were 15 casualties, and at crossings without gates or flagmen, 20. Twenty-two persons were killed and 13 were injured. The greatest number of casualties of this class on any one road occurred at crossings having gates or flagmen, but the most serious accident happened about 9 o'clock in the evening at a crossing where the gate-tender had left his post, according to his usual practice, at 8 o'clock, and the crossing was unguarded. The number of these accidents is more than 20 per cent. less than last year.

"The number of trespassers killed and injured was 7 more than last year, 130 of whom were injured when walking or lying on the track, and 29 when stealing or attempting to steal a ride on freight cars. The number killed was 91, being two less than last year. The number of this class of victims of their own folly varies less from year to year than other casualties."

New Bridges.—After considerable litigation and trouble, the Utica, Clinton & Binghamton Company has secured the right to construct a bridge across the tracks of the New York Central and the Delaware, Lackawanna & Western at Utica, N. Y., to connect its road with the Utica & Black River directly without transfer. This work will consist of 1,000 ft. of embankment, 4 lattice bridge-spans of 100 ft. each, 150 ft. of timber trestle, and six large piers and abutments, and 30 pedestals of masonry to support 350 ft. of iron viaduct. The masonry for this work will be constructed by J. J. Campbell, of Lowville, N. Y., and the Rochester Bridge Works will construct the iron work.

A new iron lattice bridge 150 ft. span, with provisions for

second track, has just been completed on the Troy & Boston at Pownal, Vt., by the Rochester Bridge Works, under the superintendence of Prof. P. C. Ricketts, of the Rensselaer Polytechnic Institute. This is the second large iron bridge built by the Troy & Boston during the past year.

Spanish Iron Ore.—The London *Engineering* says: "The exports of iron ore from Bilbao last year amounted to 3,160,047 tons, as compared with 3,295,982 tons in 1885, and 3,155,432 tons in 1884. In these totals the shipments to Great Britain figured for 2,151,137 tons in 1886; 2,050,185 tons in 1885; and 1,990,993 tons in 1884. The Low Countries took 534,687 tons in 1886, as compared with 653,919 tons in 1885; and 601,414 tons in 1884, while France took 332,103 tons in 1886, as compared with 491,085 tons in 1885, and 458,225 tons in 1884. It is noticeable that a commencement has been made with deliveries to the United States, 42,337 tons having been forwarded to the great transatlantic republic in 1886, as compared with 7,304 tons in 1885, and 2,259 tons in 1884. It will be observed that the shipments to Great Britain are increasing rather than otherwise, and that they amounted in 1886 to 68.04 per cent. of the whole exports of the year. The proportion of the exports to Holland last year was 16.60 per cent., and that of those to France, 10.52 per cent., leaving only 4.84 per cent. to represent the shipments in all other directions."

A New Torpedo Boat.—For some time past the various naval aurthorities, both English and foreign, have been looking forward with interest to the completion and trial of a couple of torpedo boats that Messrs. Yarrow and Co. have been constructing for the Italian Government. These craft are 140 ft. long on the water-line, by 14 ft. beam, and are fitted with twin screws. They have two loco-marine boilers of the usual torpedo-boat type made by this firm. These are placed one forward and one aft of the engine-room. The arrangement is such that the boilers and engines can be worked independently of each other, or either boiler can supply either or both engines with steam; so that as long as one boiler and one engine, no matter which, remained uninjured, the vessel can be manœuvred. The first of these boats was recently launched, and made her official trial last week. The following is the mean of six runs on the measured mile: Steam pressure, 130 lbs; vacuum, 26½ lbs.; revolutions, 372; speed, 24.96 miles. The lowest speed of the six runs was 22.36; the highest, 22.69. The displacement was about 100 tons, and the indicated H. P. is said to have exceeded 1,600.—*Engineering.*

English and American Iron Production.—*Iron* says: "While last year we in this country have had to be contented with very modest morsels of comfort, our cousins across the Atlantic have been enjoying extremely prosperous times. The production of pig-iron in America, which was 3,200,000 tons less than of Great Britain in 1885, came within 1,200,000 tons of it last year, 2,000,000 tons having therefore been wiped off in the one year; for while our production decreased by 379,992 tons, that of the United States increased by 1,640,017 tons. But if one derives consolation from the misfortunes of friends, it is reassuring to know that this country was not in such a bad plight as Germany, where the output of pig-iron declined last year by 411,972 tons. Although we still maintain our lead so far as pig-iron is concerned, the United States outstrips us in respect of steel. The production there of Bessemer steel last year amounted to 2,269,000 tons, against 1,570,000 tons in this country; but our superior production of open-hearth steel somewhat reduced the gap between the two, making the total production of steel in the United Kingdom 2,264,000 tons, against a total in America of 2,488,000 tons."

A New Zealand Dredge.—A dredge, built by Messrs. Kincaid, M'Queen & Co., Dunedin, for the Bluff Harbor Board, was recently launched, and named the *Alpha.* The material used in the construction of the *Alpha* was, of course, imported. She is built entirely of mild steel, and her dimensions are: Length 50 ft., over all; breadth of beam, 15 ft.; depth of hold, 6 ft. 6 in, She is capable of raising 75 tons of spoil per hour at a depth of 18 ft., and will, therefore, be peculiarly applicable for dredging purposes in such a river as she is intended to work in, its bottom being shingly and shifty. Her engines, which are also constructed by Messrs. Kincaid, M'Queen Co., are high-pressure, of 70 H. P., the diameter of the cylinder being 8½ in., and the length of stroke 12½ in. The *Alpha* is fitted with an multitubular steel boiler 15 ft. 6 in. long, and 4 ft. 8 in. in diameter, with 38 tubes. each 3 ft. in diameter. Her boilers stand a working pressure of 80 lbs. to the square inch, and have been tested and certified to a pressure of 160 lbs. to the square inch. She has a screw propeller, and is fitted with a rudder on each quarter in order that she may be the more easily handled. Her decks are planked with kauri pine.

Induction Telegraph for Trains.—The Railway Telegraph & Telephone Company, owning the patents of Wm. Wiley Smith, Thos. A. Edison and W. T. Gilliand, and the Phelps Induction Telegraph Company, owning the patents of L. J. Phelps, both of New York, have consolidated and formed a new company under the name of the Consolidated Railway Telegraph Company, with office at 13 Park Row, New York. The new company now possesses all the patents covering telegraphing by induction-telegraph to and from moving trains. This company assumes the contract of the Phelps Company with the Lehigh Valley Railroad, and is now operating the same on the New Jersey Division (50 miles) upon three trains a day each way. It also, within a short time, will begin to place this system on the main line of the New York, New Haven & Hartford Railroad, under an existing contract. Negotiations are also being carried on toward placing this system on several trunk lines. The officers of the new Company are: President, Chas. A. Cheever; Vice-President, Chas. E. Crowell; Secretary and Treasurer, Henry D. Hall; Electrician and Superintendent, Lucius J. Phelps; Consulting Electrician, Thos. A. Edison.

Cement.—The use of blast furnace slag in the manufacture of cement, it is said by a correspondent of *Industries*, is rapidly increasing in Germany, and the employment of slag cement is permitted in works carried on for or under the supervision of Government. The slag, when issuing red hot from the furnace, is dropped into water, and thus broken up into pieces the size of peas. The granular mass is then ground and mixed with lime and silicate of alumina in certain proportions, and then sifted and again ground. The cement thus produced is very cheap, and has excellent hydraulic qualities; large quantities are exported to Sydney, Valparaiso, Rio, and much of it is also used at home. Comparative tests made with this cement and Portland cement manufactured by the Oppeln Works, one of the best manufacturers in Germany, have shown that the tensile strength of the latter is 318 lbs. per square inch, and whilst slag cement gave 380 lbs. per square inch, one variety, which was used in the construction of a public building in Berlin, showed as much as 392 lbs. tensile strength per square inch. In Government contracts, slag cement is admitted not only for mortar, but also for concrete walls.

A Buoy Ship.—Barclay, Curle & Co., at Whiteinch, Scotland, recently launched the *Samson*, a buoy vessel of a most unusual character. Built to the order of the Port Commissioners of Rangoon, and intended for laying and recovering buoys, moorings, lost anchors, and chains, etc., over the district to which the jurisdiction of that body extends, the vessel measures 115 ft. by 23 ft. by 12 ft. 4 in., and her register is 205 tons. She is strongly built, and her machinery is likewise of great strength. The fittings include an enormously heavy machine, which is capable of lifting the heaviest moorings; very heavy chain cables; steam windlass to heave out on the one side and heave in on the opposite side at the same time; two powerful steam capstans, one of them able to raise 40 tons; heavy bow and stern davits; and an appliance for carrying to sea buoys of the largest class. She has also a peculiarly formed bowsprit, adapted for raising and lowering heavy weights. A boiler has been fitted on board, with capacity to supply steam to work all the machinery simultaneously. All the chain pipes throughout the vessel are of steel. The vessel is rigged as a brigantine and will proceed to her destination under sail.

New York Railroad Bridges.—It will be remembered that, in 1884, the New York Railroad Commission sent out a circular to the railroad companies of the State, asking for drawings and strain sheets of all the bridges on their lines. To collect the information required took some time, as in many cases the companies did not have the information required, and had to go back to the builders. In course of time, however, a great mass of data was received. These materials were placed by the Commission in charge of Mr. Charles F. Stowe, a competent engineer, and from them he has compiled an elaborate report which will shortly be issued, and which will be a valuable document.

The object of this investigation was to prepare the way for the establishment of a standard below which railroad bridges should not be allowed to fall. The Commission recognized the fact that the strength of bridges had not kept pace with the increased weight of rolling stock, and that the security of passengers and employés required some action. As a standard for those of the 3,500 bridges in the State, where maximum loads were not reported, the report assumed 80,000 lbs. as the weight of a locomotive on standard-gauge roads, with four driving wheels and a 14.75 ft. wheel base. The running load

behind the tender is calculated at 2,240 lbs. to the foot of track, the Board allowing, on iron members of bridges, a 10.-000 lb. maximum stress, and for wood 800 lbs. in tension.

The Canadian Geological Survey.—The proposed field-work of the Canadian Geological Survey for the coming season includes an extensive topographical and geological survey of the upper Yukon, of which Mr. Dawson will be in charge. It is proposed that one branch of the expedition shall proceed through the valley of the Stakeen River, cross the summit of the Rocky Mountains, and ascend the Liard River. Here they will pass the water-shed between the Yukon and the Mackenzie and descend the Pelly River. At Fort Selkirk, where the Pelly joins the Yukon, they will meet the other branch of the expedition, which will proceed from Chitlkat Inlet (Lynn Fiord) to the headwaters of the Yukon. From Fort Selkirk, short expeditions will be made up the branches of the Yukon on both sides, and also down the main stream. Mr. W. Ogilvy, who will be in charge of this branch of the expedition, will remain in the district during the winter of 1887, but Dr. Dawson will return next fall by the route of Lynn Fiord.

It must be regretted that a survey of the boundary between Canada and the possessions of the United States cannot be undertaken at the same time, as both expeditions would help and further one another.—*Science.*

Railroad Bridges in Connecticut.—The report of the Connecticut Railroad Commissioner for 1886 says: "Ten years ago the aggregate length of wooden bridges and trestles on the railroads in this State was 97,780 ft., or 18.52 miles, with 9,108 ft., or 1.72 miles of iron, and 3,708 ft., or 0.702 mile of stone arches. On the same roads there are now only 72,747 ft., or 13.12 miles of wood, and 3,732 ft., or 0.707 mile of stone arches, while there are 18,061 ft., or 3.42 miles, of iron bridges. This shows a total reduction of 6,356 ft., or 1.20 miles, in the length of all kinds of bridges by reason of earth filling, and the reduction of 25,333 ft., or 4.80 miles, in the length of wooden bridges and trestles by the substitution of iron and stone, and by filling. During the same time there has been added, by the building of new roads and extensions, 5,476 ft., or 1.03 miles, of wooden bridges, 874 ft. of iron, and 212 ft. of stone."

This makes the total length in lineal feet of railroad bridges in the State:

	Miles.	Per cent.
Wood	14.758	77.3
Iron	3.586	18.8
Stone	0.747	3.9
Total	19.091	100.0

The proportion of wooden bridges seems somewhat large. With a few exceptions, the bridges are short, the State having many small streams and watercourses.

Telegraphs of the World.—At a recent conference at Salzbourg, Herr Hafner, an officer of the Austrian department of posts and telegraphs, presented the following notes on the extent of the telegraphic lines of the world.

The length of aerial or pole lines, in round numbers, Herr Hafner gives as follows, in kilometers:

	Lines.	Wires.
Europe	500,000	1,000,000
America	200,000	400,000
Asia	50,000	70,000
Africa	30,000	40,000
Australia	20,000	30,000
Total	800,000	1,540,000

Underground lines have so far come into use only in France and Germany, outside of city lines. Each of these countries has about 37,000 kilometres of underground lines.

The building of 800,000 kilometers of aerial lines must have required some 14,000,000 poles, and the wires weigh about 240,000 tons.

The average price of aerial lines may be put at about 1,000 francs per kilometer (or $320 per mile), while underground lines cost five or six times as much.

There are now 12 submarine cable lines between Europe and America, the longest being the French line from Brest to St. Pierre Miquelon, which is 4,905 kilometers long. Besides these, the five great divisions of the world are now all united by submarine lines.

Steamboats in Siberia.—At a recent meeting of the Russian Mercantile Marine Society, M. Igoumnoff read an interesting paper on the present condition of shipping on the Siberian rivers. The first steamer in Siberia made its appearance in 1842, but it was not until 1845 that one of any size began to run; the pioneer vessel being the *Osnova* or *Basis*, having machinery of 60 H. P. In 1854 the total number of steamers in Siberia was 5, in 1860 there were 10, in 1865 the number had increased to 23, in 1876 to 43, and by the end of last autumn to 58. This is not a large number for a territory larger than all Europe or Canada, and which Russia has held for 300 years. Besides steamers there are 200 barges, ranging in length from 200 ft. and 250 ft., and 100 from 150 ft. to 200 ft. long. The most powerful steamer on the Siberian rivers is one of 160 H. P. The center of the traffic is Tiumin, through which goods to the extent of 4½ million poods, or 70,000 tons, pass every year. It is the drawback of the Siberian rivers that they nearly all flow to the Arctic region, and although some years ago English navigators penetrated to the Obi and Yenesei, the perils of the passage through the Kara Sea nipped the enterprise in the bud. At present there is little inclination to increase the steamers in Siberia, as its raw produce cannot find a ready market in Russia, owing to the competition in the corn, hide and tallow trade. About 8,000 peasants migrate thither every year, and the extension of the railroad system is opening up the country, but none the less its progress is very slow.

Harrisburg Bridge.—The Cumberland Valley Railroad Company is rebuilding its bridge over the Susquehanna at Harrisburg, Pa. The first bridge erected by the company at this point was finished January 16, 1839. It was a lattice bridge, 4,228 ft. in length, the deck of which was used for railroad purposes, the cars being hauled across by horses. Below the deck were two roadways for ordinary wagon travel.

This bridge was destroyed by fire December 4, 1844. On February 3, 1845, a contract was made with Mr. Eleasor Kirkbride, for the erection of a new bridge. Owing to various misfortunes, this bridge was not completed for a couple of years. In 1850 it was strengthened for railroad purposes, and its use discontinued as a wagon bridge. In 1856 it was substantially rebuilt as a Howe truss. The lower chords were renewed in 1871 at a cost of $72,520. In 1878, it became necessary to give additional strength to the structure, and arches were put in as auxiliary to the truss at an expense of $33,105. All the piers have been rebuilt in a most substantial manner at an entire cost of $113,359.

In September last, contracts were made with the Union Bridge Company, of New York, and the Edge Moor Iron Company, of Wilmington, Del., to replace the present wooden bridge with an iron one; the Union Bridge Company contracting for the western half, and the Edge Moor for the eastern half. The cost of this work, will be about $225,800. The Union Bridge Company has just completed its half of the bridge, and work is in progress on the other half.

Not a Promising Field for Young Engineers.—The *Indian Engineering* says: "The Bombay Public Works Department have for years been far behind all other provinces and lists in point of promotion. But 1886 has changed matters somewhat for the better, for they have had no less than six steps, five by retirement and one by death, of highly graded officers: Colonel J. M. Creig and Colonel J. R. Maunsell, Superintending Engineers; Colonel B. H. Matthew and Major M. T. Macartney, Executive Engineers, first grade; Mr. W. Clarke, Executive Engineer, second grade, all retired—and Colonel E. P. Gambier, deceased. During the current year there will, it is thought, be three retirements—those of General Goodfellow, Colonel John LeMesurier, and Mr. F. D. Campbell, Chief, Superintending and First Grade Executive Engineer, respectively. To judge how bad things were last June, before this small run of promotion came in, the following figures show the length of service of the *senior* in each grade: Executive Engineer, first grade, 28 years; second grade, 24 years; third grade, 19 years; fourth grade, 15 years; Assistant Engineer, first grade, 13 years.

"One step—that of Colonel Maunsell—still remains to be filled, but the *present* seniors of the above grades are of 28, 20, 19, 11, and 10 years' service respectively. It is something approaching to almost a scandal that an officer of 20 years' good service, who is talented, bears a blameless reputation, and has a high University degree, should still be in the second grade of Executive Engineers. Such is Bombay luck!

New Railroads in Norway.—Although no definite decision has been, or is perhaps for some little time likely to be arrived at, as to the prejected railway from Bergen to Christiania, the time is not far distant, when the two largest towns in Norway will be connected by a railroad line. Whatever route may be adopted, and there are several on the tapis, this new line will offer very considerable engineering difficulties, and it is only within the last few years that the scheme has been looked upon as at all practicable. The latest plan—the Aurland line—is said to possess several advantages over its predecessors, but still it will, for a distance of 20 kilometers, have to run at a height of 3,000 ft. above the sea level. Its highest point—Gjeitserryggen—is about 1,130 meters, or some

3,600 ft. above the level of the sea, but this is 170 meters lower than the highest point of the Rundals scheme. This latter line would also necessitate the railroad running at a height of 3,000 ft. or more, for the much longer distance of 70 kilometers. Among the advantages of the lower line are less risk for snowdrifts and less frequent fogs, and the supply of watei appears to be more abundant. Also as regards the inhabitants of the surrounding country, the Aurland line is more favorably positioned than its rivals. The longest distance between the 'Salters"—the mountain pastures where the cattle are kept during the the summer time—is only 8 kilometers, while it, on the other line, amounts to 40 to 50 kilometers, and the Salter time is only six weeks on the latter, against ten to sixteen weeks on the former. The soil is also more tractable on the Aurland line; there are, however, a couple of tunnels, through the Klovfjeld, a length of 3.5 kilometers, and through the Grundfjeld, a length of 1.5 kilometers.—*Engineering.*

Blast Furnaces of the United States.—The *American Manufacturer* says: "Our usual monthly table, showing the condition of the blast furnaces of the country on April 1, makes the following showing:

Fuel.	In blast. No.	In blast. Weekly Capacity.	Out of blast. No.	Out of blast. Weekly Capacity.
Charcoal	59	11,337	119	13,210
Anthracite	143	39,477	59	14,314
Bituminous	151	86,709	58	24,375
Total	353	137,523	236	51,899

"As compared with a month ago, this shows a reduction of 2 in the number of charcoal furnaces in blast, an increase of 1 in the number of anthracite, and an increase of 5 in the number of bituminous, making a total increase in the number in blast of 4.

"The capacity for production of the furnaces in blast at the present moment is greater than at any previous time in the history of iron manufacture in this country. The nearest approach to it was on February 1, 1887.

"We estimate the production of pig-iron for the first quarter of 1887, on the basis of our monthly reports, as follows, in gross tons:

Charcoal	127,652	tons.
Anthracite	539,432	"
Bituminous	1,000,952	"
Total	1,668,036	

"This is at the rate of 6,672,144 gross tons a year. The production for 1886 was 5,684,543 gross tons."

Railroad Progress in Central Asia.—Private enterprise appears to be coming to the aid of the Russian Government in the matter of railway development. Two applications have been recently made to the Minister of Railways for permission to extend the Orenburg Railway to Uralsk, in the Kirghiz region. This implies another advance of the locomotive into Central Asia. Until recent years the Russian advance towards India lay through Turkestan in the direction of Orenburg, Tashkent and Cabul. While this movement was in progress Russia pushed her railway system to Orenburg, on the Asiatic border. The movement then changed to the Caspian Sea, io the direction of Krasnovodsk, Merv, and Herat. This led tn the decadence of Turkestan, and the more the advance upon Herat grew into favor the less disposed the Russian Government became to concern itself any further with the extension of the Orenburg Railway to Tashkent. The Orenburg district has, however, developed so much since the completion of the line that sufficient enterprise now exists among the commercial classes to promote the construction of another extension further into Asia. as far as the Cossack town of Uralsk. Two schemes are proposed; one from the Toliminsk station on the Orenburg Railway to Uralsk, a distance of 150 miles, and another from Pokrova, on the Volga, opposite Saratoff, to Uralsk, a distance of 250 miles. In both cases the line would traverse a flat, fertile steppe, like the prairies of America, and the cost in either case would not very much exceed $15,000 a mile. There are no towns of any size between the points, but a considerable trade is done at Uralsk, and the promoters are content to construct and work the lines without a Government subsidy. Last week the Minister despatched a commission to examine the two routes, and whichever be adopted, the European railroad system will make one more advance into Asia. By degrees there is very little doubt that the locomotive will penetrate to Tashkent, although not so rapidly as the Siberian line will push beyond Tobolsk and the Transcaspian line past Bokhara.

New Furnaces of Troy Steel Company.—The new furnaces of the Troy Steel Company situated on Breaker Island in the Hudson River, opposite the works at South Troy, are soon to be put in operation. These furnaces are to furnish material for the Bessemer plant of this company, which was the first operated in this country. It was proposed at first to convey the molten metal from the island on which the blast furnaces are situated to the Bessemer plant on the east shore by boat, but this scheme has been abandoned, and the iron will be run into pigs and will be transported in that form. The furnaces consist of six stores, three furnaces, with necessary engine and store houses, all built upon a foundation of concrete 20 ft. deep.

It is estimated that 3,000 tons of material per day will be required to supply these furnaces. The ore used will be from the Lake Champlain mines, and flux from the vicinity of Fort Edward, N. Y., where a branch track ½ mile long is to be built for its transportation. In order to supply this new enterprise with ore, coal and flux, a branch railroad has been constructed by the Delaware & Hudson Canal Company from a point on the main line about 2½ miles north of Albany to Breaker Island. This branch is about 2 miles in length and consists of 3 spans of 225 ft. each, pin-connected truss bridge across the West Branch of the Hudson, one span 150 ft., riveted lattice, across the Erie Canal, 1½ miles of timber trestle and ¼ mile of embankment.

The construction of this branch was commenced about two years ago, but was not completed until the early part of this winter, owing to delays caused by difficulty in securing right of way, and to damage caused by high water and ice on two separate occasions by which two trestles and six timber piers were carried away at the point where the three spans of pin-connected truss now spans the stream.

The total cost of this branch has been $160,000, and that of the furnaces upward of $2,000,000.

Locomotive Driving-Wheel Tires.—At a recent meeting of the Engineers' Club of Philadelphia, Mr. Theodore Lewis presented a paper on 3 in. *vs.* 4 in. steel tires, from which the following extracts are taken:

"The question as to the desirability of using tires 4 in thick has been before the makers and users of tires for some years past, and there has been a steady increase in the number of roads deciding in favor of the thick tires.

"The average thickness of tires used in this country is probably 3 in., and the argument of those favoring the increase of thickness to 4 in. has been that as a tire is scrapped when worn down to 1¼ in., the cost of this waste metal is carried by a wear of 2¾ in. of metal in the case of the 4 in. tire, while in the case of the 3 in. tire the same amount of waste metal is carried by a wear of 1¾ in.; or, in other words, with a 4 in. tire the amount scrapped, is 45 per cent. of the amount worn off, while with a 3 in. tire it is 71 per cent. If the wearing qualities of both tires are the same, the 4 in. thick tire should be the most economical, and this seemed to be the opinion of those using 4 in. tires, until at the November meeting of the Western Railway Club at Chicago, Mr. G. W. Rhodes presented some figures, showing that on the Chicago, Burlington & Quincy Railroad they had obtained a very slight increase in total mileage from 4 in. tires over that obtained from 3 in. tires. He stated that from an average of 45 sets of 3 in. tires worn out he had obtained a total mileage of 131,627 miles per tire, or 4,250 miles per $\frac{1}{16}$ in. of metal worn off. From an average of 13 sets of 4 in. tires worn out he had obtained a total mileage of 133,956 miles per tire, or 3,252 miles per $\frac{1}{16}$ in. of metal worn off. This makes a difference of only 2,329 in the total mileage of the tires.

"These mileages may appear very small, and it should be said that all the tires were on switching engines, which is severe service. In the same report the mileage made on freight engines is given as 7,500 miles per $\frac{1}{16}$ in. of wear, and that made on passenger engines as 10,000 miles per $\frac{1}{16}$ in. wear.

"It should be stated that in taking these averages the entire 45 sets of 3 in. thick tires were worn out and scrapped, while with the 4 in. tires there were 76 sets, of which but 13 sets were worn out, and it is fair to suppose that if there were differences in the tires these 13 sets were the poorest and that the average of the 76 sets will probably make a better showing for the 4 in. tires. It should be noted that while physical tests from 3 in. and 4 in. tires show very little difference, the amount of work on the 3 in. tire in the process of manufacture is considerably greater than on the 4 in.

"These results have led to the discussion (to be brought up at a future meeting of the Western Railway Club) as to whether the additional weight in the 4 in. tire is not in itself the cause of more rapid wear, and whether it does not result in greater wear of the road-bed and more severe shocks to bridges."

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery venue, San Francisco Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, JUNE, 1887.

THE office of the RAILROAD AND ENGINEERING JOURNAL is now at No. 45 Broadway, New York, having been removed from No. 23 Murray Street on May 1. All communications for the JOURNAL, its proprietor or its editors should be addressed to No. 45 Broadway, New York.

IN this country of frequent changes it is a fact, we think, worthy of note, that the card of Fuller Brothers & Co., which will be found in another column, is the renewal of an advertisement which first appeared in the JOURNAL some 35 years ago; and that the address of the address of the firm was the same then as now—an almost unprecedented occurrence in New York.

THE American Society of Mechanical Engineers presents a varied and interesting programme for its spring meeting at Washington, which begins just as this number of the JOURNAL is issued. The subjects of several of the papers promised for the meeting are of importance, and the number of the papers shows no lack of interest in the Society on the part of its members.

THE use of steam at a high pressure and of the triple-expansion engine seems to have become established as the latest practice in marine engineering. Some are disposed to go still further, for a new steamer in England is provided with quadruple-expansion engines. This is an experiment, however; but the triple-expansion engines have so far shown very good results, both in economy and ease of working.

Probably the next advance in marine construction will be in the use of twin screws, which have already been applied in a number of war-ships, but have not come into general use. Twin screws are not a new device by any means, and were successfully used many years ago; they are strongly advocated by Commander Chadwick in a recent article in *Scribner's Magazine*.

An excellent example of a triple-expansion marine engine of American design and construction will be found on another page. It is for use on a steamer on the great lakes, where so much of our best marine construction is to be found.

THE brake trials at Burlington are in successful progress, but are not yet sufficiently advanced to give definite results, and the publication of a mere list of stops hardly seems worth the space which it would occupy.

All parties seem to have profited by the experience gained in last year's tests, and several improvements have been made. The most notable of these is the use of electric apparatus for the purpose of securing the almost simultaneous setting of the brakes throughout a train, thus avoiding the delay necessary for the passage of the air through the brake-pipes, which is sufficient to cause severe shocks in a long train. There are minor improvements which increase the efficiency of the different brakes, and perceptible progress has been made.

THE proposed lease of the Boston & Lowell Railroad to the Boston & Maine Company is a step in advance in the process of consolidation of New-England railroads, which has been going on for some years past. In the beginning all railroad companies were small, each controlling a few miles of road only; a few, that is, in comparison with the great companies of to-day. In New England this small company system was closely and jealously adhered to until a few years ago; so closely in fact, that a legislative enactment, passed after a long struggle, was required to force the Boston & Worcester into the consolidation with the Western Company, by which the Boston & Albany Company was formed. Even after time had showed the beneficial results of this consolidation, but little change was made in this direction for some years, although the Old Colony absorbed some of its extensions, and finally completed its system by the purchase of the Boston, Clinton & Fitchburg tangle of short roads. The Eastern Railroad attempted a career of extension, but its disastrous failure followed a too hasty and reckless expansion. Recently, however, a new era of consolidation has begun; the Boston & Maine absorbed the Eastern; the Boston & Lowell took in its northern connecting lines in New Hampshire, and the Fitchburg completed, by consolidation, its line from Boston to the Hudson River through the Hoosac Tunnel.

Now, arrangements have been made by which the Boston & Maine is to lease the Boston & Lowell, thus becoming the largest and most important corporation in New England, and practically controlling all the lines from Boston to Northern New England and Canada. The Boston & Providence, it is also said, is to be absorbed by the Old Colony, and made a part of that system. The Boston lines will then be controlled by four strong companies, leaving out only the New York & New England, which is probably still in the market, and which, it is not unlikely, will before long become an appendage of some wealthier corporation.

WHATEVER may be said of the small company system —and from one point of view there are many arguments in favor of it—it is not generally conducive to the best management. The small company is very apt to be controlled by small men, and, even if it is fairly successful financially it is usually very slow to make changes

and to introduce improvements. Thus, while the average returns from the New England roads have been better than from those in any other part of the country, many of them—and not all of them the poorest—are much behind the Western lines in their appliances and methods, and do not show signs of improvement. Consolidation has not always remedied this, for too often the policy which has grown up under the small company has survived the extension. But with this extension there come at least the means and opportunity of doing better, while the younger men, who are growing up to replace the old managers, have the advantage of training in a better school and with a wider range of view.

THE best attainable authority on the subject gives the length of track laid on new railroad lines in the United States for the four months of the current year to the end of April at 1,564 miles. More than one-half of this was in the Southwest—Kansas, Colorado, the Indian Territory and Texas. A considerable part of the remaining half was in the Southern States. As in January, February and the greater part of March the weather was very unfavorable for track-laying in the North and Northwest, those sections were hardly able to contribute their fair share and may be expected to show an increased mileage later in the year.

In view of this fact, and considering the amount of preliminary work on new lines which has been already done, the new mileage of the present year may be expected to reach a high figure, and the estimate made by our contemporary, the *Railway Age*—10,000 miles for the year, with a possible excess over that figure—does not seem an extravagant one. There are several long lines now well under way, and with such financial backing that there is every probability of their completion, while more than the usual number of branch lines and feeders have been undertaken by responsible corporations.

It is to be regretted that so much of the new mileage, completed and under construction, is of parallel and competing lines, built, not so much to develop new country or serve a growing traffic, as to divide existing business and secure it for certain main lines. Much of the money expended in this direction is absolutely sunk and is of no use, except so far as it may be said to protect existing investments. Under more judicious systems of management much of it might be reserved for investment where it is really needed.

THE annual statement of the American Iron & Steel Association for 1886 covers one of the best years the iron trade has ever had in this country. The production of pig-iron was the largest on record, while the steel production also exceeded that of any previous year. The manufacture of rolled iron, though greater than in 1885, was exceeded in several previous years; a fact which is accounted for by the increasing use of steel for many purposes. The iron rail manufacture, for instance, has entirely ceased, and steel is rapidly superseding iron for the making of nails.

While the year was a prosperous one so as far as the demand and the amount of production was concerned, there was not such an increase in prices as might have been expected. Pig-iron, rolled-iron and other standard products, for instance, showed only a very small advance over the lowest prices prevailing during the period of depression. The only notable increase was in steel rails, which showed a heavy advance under the influence of a special demand and a necessarily restricted production

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THE board of managers of the Association of Engineering Societies, at its last meeting, adopted an address to the local societies and clubs of Engineers, suggesting the formation of a national society or union, in which all shall be represented. The present Association, which includes seven societies, exists for the purpose of publishing a journal of their proceedings only, and has very limited powers. To enlarge these, and secure joint action on other matters, is the object of the present movement, which is not the first attempt of a similar kind. The address calls a Convention of Societies to arrange the proposed union.

WE are informed that the Pennsylvania Railroad Company intends to make exhaustive trials on its line of a compound locomotive on the Webb system. The trial, it is said, will be made with a London & Northwestern locomotive built under Mr. Webb's own supervision. which will be brought over for the purpose. This will be the first really thorough test of the compound system in this country, and its result will be watched with much interest.

THE discussions at the railroad clubs during the past month have been chiefly on the revision of the rules for interchange of cars. As these rules have now been submitted to a pretty thorough discussion in the different sections represented in the clubs at Boston, New York, Buffalo and Chicago, members ought to be able to consider them intelligently at the Master Car Builders' Convention, and to decide quickly on whatever changes or amendments may be required.

RAILROAD officers and editors of technical journals have for some time felt inclined to believe that every white male citizen of the United States had felt it his duty to invent a car coupler. A new terror is now added to life by the statement (in a reliable daily paper) that a woman—and a colored woman at that—has invented a coupler " which promises to supersede all others," as all of them have done for so many years past.

COMBUSTION.

IF the books, papers and articles which have been written on this subject were collected together they would make quite a library by themselves. Nevertheless, there is no theory of combustion that is entirely satisfactory, and practically the grimy firemen seem to know more about it than the scientific people do. A very good story is told of an invention for improving combustion in locomotives, which was tried on a New-England railroad some years ago. It consisted of some elaborate arrangement of pipes for admitting air at the front of the engine and conveying it to the fire-box. A trial trip was made with invited guests, champagne, etc., etc. The engine did not make steam freely and failed to make time, arriving at its destination a half hour or more late. While the guests were firing up with liquid fuel, the inventor of the device went unobserved to the locomotive runner, and holding up a seductive twenty-dollar bill, told him that if on

the return trip he would make time the bill would be his. The invento then joined his guests and explained to them that the reason his invention had failed so far, was because the pipes required "adjusting." At the same time the locomotive runner, unobserved, went to the front end and stopped up both the pipes which scooped in the air, turned his engine around, and on the down trip made up all the time lost in coming up. He was then congratulated by the inventor, who handed him the coveted twenty-dollar bill. When this was securely deposited in the trouser's pocket of the engineer he told the inventor, "yes, we got here all right, but it's because I stopped up them pipes."

In 1858 an "Elementary Treatise on the Combustion of Coal and the Prevention of Smoke," by C. Wye Williams was published in the "Weale Series." In that book he explained the need of introducing a supply of fresh air above the fire, in order to produce perfect combustion. The result was that a great variety of plans were devised and adopted, for admitting air above the fire in locomotive and other boilers, some of which are now in use, but a fireman discovered that by putting an inverted scoop-shovel in the opening of the furnace-door he could prevent or diminish the quantity of smoke produced. After numberless inventions have been tried, with the exception of the brick-arch, that of the ignorant fireman in the form of a deflector is about the only one which has survived and is now used to any considerable extent.

Leading questions, relating to the most economical rate of combustion, the proportion of grates and fire-boxes, are still in dispute, and the most opposite opinions are held with reference thereto by well-informed persons. Thus some engineers hold that slow combustion is the most economical; whereas, others aim at producing intensity of heat, that is to burn the greatest possible quantity of fuel within a restricted space. Some hold that the larger the grate the better, others that the smaller it is, provided a sufficient amount of fuel can be burned in it, the greater the economy. Some advocate the use of small grates and fire-boxes; others small grates and large fire-boxes. Deep and shallow fire-boxes, both have their advocates, and it may be said that hardly any principle relating to the proportions of fire-boxes and grates for locomotives is settled beyond question. This leads to the suspicion that perhaps the proportion of grates and fire-boxes is not a matter of great importance. At any rate it is not likely that any very definite conclusions can be reached from purely theoretical considerations, although it seems very probable that an exhaustive series of experiments, made by a competent person to determine the most economical proportions and forms of locomotive boilers, might involve information which would be of very great practical importance. Perhaps in the future some one or more railroad managers may recognize the value of that kind of knowledge, and have the experiments made which are needed to teach us what form and proportion of locomotive fire-boxes are the most economical. In the meanwhile we will be obliged to feel our way as best we can.

In discussing combustion, the text-books generally treat of its chemistry alone, and tell us how much oxygen must be supplied for a given quantity of fuel to burn it perfectly. While it is very important to know just the proportions in which carbon and hydrogen unite with oxygen, and that a certain amount of air must be admitted above the fire to burn coal perfectly, yet, notwithstanding all we know of this aspect of the subject, locomotives still smoke about as badly as ever, and no marked amount of economy, such as has resulted from the use of compound marine engines, has been effected in locomotive service and, notwithstanding our knowledge of chemistry, the practical firemen, who are ignorant of all science, generally produce better results than "them literary fellers" can.

Some mechanical engineers build their fire-boxes with many holes in the sides of the fire-boxes to admit air. The firemen plug them up, and find that their engines make steam better then they did with the holes open. The chemist teaches that the production of black smoke is a great waste of fuel. The fireman will tell you that he likes to see it roll out of the chimney, because that shows that "she will do her work.'

The fact is that our knowledge of chemistry has not helped us much in burning fuel. There are some mechanical principles involved in the process, which, to a very great extent, determine whether the chemical combinations which occur during combustion will be complete or not. It is only lately that these have been understood and recognized. Some of them were very clearly explained in a paper read before the Iron and Steel Institute by Mr. Frederick Siemens in 1884, and afterward in a discussion by the same distinguished authority of another paper. His remarks will be quoted at some length, because his explanation of what may be called the mechanical theory of combustion would be certain to lose in clearness if put into other language. In the paper referred to the distinguished author said:

It can be easily shown that when flame is brought into contact with any solid body, it is more or less quenched, according to the substance, size and temperature of the body. A very simple experiment in proof of this, and one which is familiar to most people is the following: Take any ordinary illuminating-gas flame, such, for instance, as a batswing, and place a glass rod or tube into the middle of it; the flame will immediately burn dull, and a large quantity of lamp-black will be deposited on the piece of glass. This action is most marked when the rod is cold, but takes place, though in a less degree, at any temperature, for the reason that the material to be heated is necessarily always at a lower temperature than the flame, also owing to the disturbance in the combustion caused by contact of the solid substance with the flame. I hope shortly to treat this subject more fully from a physical point of view; but the experiments I have made establish the following most important fact, namely, that a good flame, or in other words, perfect combustion, can only take place in an open space or in one of sufficiently large size to allow the gases to burn out of contact with solid material. * * * *

When it is considered that the temperature of the water in a boiler working at 60 lbs. pressure on the square inch is only 311° Fahr., whilst the temperature of gaseous flame may be taken at 4,000° Fahr., it will readily be perceived what a quenching effect the metal of the boiler, which is of course at the temperature of the water, has upon the flames. In this case the principle has been followed of letting the active flame consume itself in the open space of the tube without allowing it to touch the sides until after complete combustion may be brought into direct contact with solid bodies. By such an arrangement, complete and smokeless combustion is obtained, with the result of longer life to the boiler, the sides of which more rapidly deteriorate through direct contact with the flame than from any other cause. As the heat of the flame which is not transmitted by radiation comes after complete combustion into direct contact with the sides or flues of the boiler and its regenerators, it is completely utilized, and a saving of fuel to the extent of 25 per cent. is secured by this method of heating.

The results obtained in actual practice show that there can be no doubt that almost all heating apparatus used in the arts, in which direct contact of flame with the substances treated is not necessary for chemical reasons, will be materially improved by the application to them of the principle of transmitting the heat of flame by radiation only, while the heat of the completely burnt products of combustion is better utilized by contact.

Complete combustion of the fuel is ensured by this method of heating, and it will therefore entirely abolish the smoke nuisance. Smoke is never formed when combustion is complete, being always caused by flame coming into contact with solid bodies, the process of combustion being thereby checked. This is for instance, the reason why brick-kilns generally smoke so abominably, for in them scarcely developed flame is forced to impinge immediately on cold bricks and can therefore only act in a very incomplete and uneconomical way. The author has frequently made the observation with

regard to regenerative furnaces, that a short combustion chamber invariably gives very unsatisfactory results, and accounts for it by the fact that the flame is hardly formed before it has to pass through the outlet ports and into the chequer work of the regenerators, where its combustion is checked and smoke is formed in consequence. To work well, a brick or pottery-kiln should be so built that the flame can burn itself out in a free space before being brought into contact with the bricks or pottery. Zinc-distilling furnaces, and in fact all furnaces in which muffles, tubes, crucibles and other vessels are used, will in the same way be much more economically worked on this new principle. * * * *

There were several ways of saving fuel; one was by good combustion; a second was by increasing the intensity or temperature of the flame; and another was by utilizing the heat of radiation. If the flame was allowed to touch the sides of a boiler, there would naturally be smoke on its inner surfaces, and the radiant heat of the flame not being able to penetrate such an atmosphere of smoke, the boiler could not gain the advantage of it. Hence the necessity not only of perfect combustion in the first instance, but that the flame should be maintained clear and bright. Then, again, as regards the production of a higher temperature in the flame, not only was the radiation increased thereby, but more heat could be abstracted by contact from the products of combustion. There were, therefore, several causes combining, each of which contributed to effect a saving, and 25 per cent. and more could be easily gained if proper arrangements were made. With the boilers which were in use at the author's glass works at Dresden, and at other works in Germany, there was an average saving of 25 per cent. over boilers formerly heated by gas on the non-radiation principle, so that, in comparison with boilers heated by direct flame, he thought there should be a still greater saving. It was necessary, however, to work the boiler continuously, for it was only worked in the daytime and stopped at night. The saving effected by the use of gaseous fuel was not so great. * * * *

He might have commenced by tracing the action within a flame from its beginning to its end, from the moment the gases met until combustion was perfect and even further until the heat had been fully abstracted from the products of combustion. If flame was traced in that way, it would be found to pass through various successive stages materially differing from one another. There were, as he had shown in the paper, two special stages which required quite different development and treatment. The first stage was that of active combustion, the essentially chemical process by which all heat was produced. The second stage was after combustion had been completed, and the products of combustion alone had to be dealt with, which contained the greatest portion of the heat produced during the first stage or that of combustion. Now these two stages were so entirely different that it was quite reasonable that they should be separately and differently treated, and should not be considered as one, as had been invariably done hitherto. It was necessary to treat the flame according to its stage, and it had been one of the objects of his paper to detail that in a practical way. He had stated that in the first stage, that is, in that of chemical action, the flame ought to be allowed free space within which to burn; it should not be interfered with by surfaces of any kind and it should be allowed freely to radiate out its radiant heat. In the second or neutral stage, the products of combustion had very little power of radiation, and as they did not injure surfaces upon which they impinged, they should be brought into contact with the surfaces to be heated for the purpose of abstracting their heat. He need not say any more upon this, because it had been clearly stated in the paper; but what he might speak about was the scientific theory which explained why combustion was interrupted when the flame met with solid surfaces, and why the solid surfaces themselves suffered so much, not from the heat of the flame, but from the action of the flame; and why, further, the flame had such power of radiation in its first stage and so little in its second. These were all questions that could be answered by accepting one or other of the theories of combustion. There had been various theories proposed, but it was agreed in all these theories that the flame or the gases in combustion forming the flame were violently excited, and that the molecules of gas were rotating around one another, or were in motion of some kind. He thought the electric theory had the best chance of being the right one, and he would accept it because it explained all these occurrences. According to the electrical theory, a flame consisted of explosions of lightning very numerous and very minute. In accepting this theory, it was at once evident why a solid body brought into such a flame would obstruct its action, such solid body having the effect of arresting the motion of the gas by attraction and adhesion. Consequently, the gases which were supposed to revolve were obstructed in their motion, and not being able to move, combustion could not continue, at least in those parts nearest to the opposing surfaces. The consequence was that there was less intense heat, and that smoke was produced instead, enveloping the obstructing surfaces; and so radiation could not act, because it could not penetrate the cloud of smoke in which the flame was enveloped. Then, as regarded the action of the flame on any body, it was quite natural to expect that if flame was composed of innumerable flashes of lightning, no body exposed to it could withstand its action for any length of time; and hence it was that bodies were so soon destroyed when exposed, as one gentleman had described it, to the "cutting action of the flame." The flame in the first stage being composed of innumerable lightning explosions accounted also for its radiant power. A flame radiated much better than a solid surface. A solid surface radiated only from its outer surface, and from that surface only toward one direction, while a flame radiated from every point within it, and on its surface in every direction or from every point within it and on its surface in every direction or from every point of its entire volume toward every direction. The Argand burner would serve as an illustration of a hollow flame, the light radiating outward, not only from the outer surface, but from the inner surface through the flame itself; the heat and light obeyed the same law in this respect. If the area of a flame was doubled it would radiate four times as much as originally; whilst a solid body, if doubled in area, would radiate only twice as much as before That only accounted for the employment of such a large volume of flame in applying radiation; in fact, it could not be made too large from an economical point of view, because the radiation from a body of flame increased in a much greater proportion, than the increase in its volume. In the second stage of the flame where no chemical action was going on, there was also no free carbon to emit heat by its incandescence, and it was therefore natural that there should be little radiant action.

As stated by the distinguished author of the paper quoted from, his experiments have established the following most important fact, namely, "*that a good flame, or in other words perfect combustion, can only take place in an open space, or in one of sufficiently large size to allow the gases to burn out of contact with solid material.*" This being established, it is an important advance in our knowledge of the conditions which must exist to produce perfect combustion. It has long been known, that the temperature of flame is very high —4,000 deg. Fah. Mr. Siemens says—and that when it is reduced, combustion ceases. For this reason, fire-brick has been used a good deal in boiler furnaces in the form of brick-ashes and otherwise, because it does not conduct the heat away from the fire as rapidly as plates do which are in contact with water. Mr. Verderber, a Hungarian engineer, some years ago, experimented with a locomotive boiler, the fire-box of which was lined with fire-brick and which had no water spans at all around the fire; the object being to maintain a high temperature and thus produce more perfect combustion. The experiments of Mr. Siemens show that not only is a high temperature essential, but that "when flame is brought into contact with any solid body it is more or less quenched." The inference which may fairly be drawn from these considerations is that combustion should be carried on in a fire-box whose sides consist of some non-conducting material and that the fire should come in contact with these sides as little as possible, that is, that the flame should have "free space." This means that the fire-box should be large, and if it was made of a spherical or cubical form its sides would present the least surface to the fire. Here the practical men have again been ahead of the theorists, as the old-fashioned "egg-shaped stove," for burning bituminous coal, fulfills all of the above conditions.

Of course a fire-box without heating surface would not generate any steam, and all the heat from the fire would be transmitted to the water in the tubes. As they would then have more work to do, it would be essential that the amount of heating surface in them should be increased. This could be done by adding to their number or to their length, or by adopting ribbed boiler-tubes, such as were illustrated in the last number of the JOURNAL.

These considerations then suggest that a locomotive boiler with a large fire-box, approximating as nearly to a cubical form as practicable, lined with fire-brick, and with a small open grate and an increased flue area, would be more economical than the boilers now in use.

NEW PUBLICATIONS.

Technology Quarterly: Vol. I, No. I. Issued from the Massachusetts Institute of Technology, Boston.

This new magazine is intended to represent, as far as possible, all the departments of the Massachusetts Institute of Technology, and is published by a board of editors chosen from the Senior and Junior classes of the Institute. Its object, as stated in the introductory number, is to preserve the results of original investigations made by students in the course of their work, and it is also expected that the articles of this class will be supplemented by contributions from the Alumni of the Institute. The student contributions, however, are to form the basis of the work.

It is probable that there will be little or no difficulty in securing material enough for a very creditable quarterly on this basis. This first number contains contributions from the departments of civil, mechanical and electrical engineering, chemistry and natural history, covering a very extended field.

BOOKS RECEIVED.

The Relations of Railroad Managers and Employes; by Dr. W. T. Barnard. Baltimore; Press of the Employés' Relief Association.

Fifth Annual Report of the Baltimore & Ohio Employes' Relief Association; S. R. Barr, Secretary. Baltimore; issued by the Association.

Special Report of the Massachusetts Railroad Commissioners to the Legislature on the Disaster on the Dedham Branch of the Boston & Providence Railroad. Boston; State Printers. This is the report of the Commission on the Bussey Bridge Accident of March 14, and is referred to elsewhere.

Statistics of the American and Foreign Iron Trades for 1886; Annual Statistical Report of the American Iron & Steel Association; James M. Swank, Manager. Philadelphia; issued by the Association. This report, as usual, contains much valuable statistical information, some of which we have already made use of elsewhere.

The American Ephemeris and Nautical Almanac; 1887. Washington; issued by the Bureau of Navigation, Navy Department.

Selected Papers of the Civil Engineers' Club of the University of Illinois; 1885–86 and 1886–87. Champaign, Ill.; issued by the Club. This contains papers read before the Club on Economical Specifications; Topographical Surveying; Street Pavements; Wind Pressure; City Engineers' Work; Breakwaters at Chicago; Water Supply for Cities; Mountain Railroad Location and Hints to Students on the Education of an Engineer. The last-named paper is by Professor Baker; the others are by student members of the Club and show evidences of creditable work.

Transactions of the Institution of Civil Engineers of Ireland; Fifty-first Session. Dublin; printed for the Institution.

Proceedings of the United States Naval Institute: Volume XIII, Number 1. Annapolis, Md.; published by the Institute.

United States Geological Survey; Monograph X. Dinocerata. By O. C. Marsh.

Bridge Disasters in America. The Cause and the Remedy. By Professor George L. Vose. Boston; Lee & Shepard, Publishers.

Proceedings of the General Time Convention: Held at the Hotel Brunswick, New York, April 13 and 14, 1887. W. F. Allen, Secretary.

The Official Railway List for 1887. Chicago; published by the Railway Purchasing Agent Company. This an exceedingly useful publication, containing a directory of the railroads of the United States and Canada, with the names and addresses of the officers, including those of the engineer and mechanical departments. It is of convenient size and well adapted for a place on the desk.

Light on the Law: A Reference Book on the Act to Regulate Commerce. The *Railway Age* Publishing Company, Chicago. This is a convenient handbook, containing the new Inter-State Commerce Law, with much collateral matter intended to throw light on its provisions. This collateral matter includes the Reagan and Cullom bills as originally presented to Congress; a summary of the debates in Congress which preceded the enactment of the law; opinions of Mr. Albert Fink and others on the law; the organization and first official actions of the Commission. It is illustrated by portraits of the five Commissioners.

Natural Principles Regulating Railway Rates; by Gerrit L. Lansing. Chicago: the *Railway Age* Publishing Company.

Record of Transportation Lines owned and operated by and associated in Interest with the Pennsylvania Railroad; 1886. This statement or report, issued yearly by the company, shows that on December 31 last, the lines of the company were in all 7,404.37 miles in length, having 11,720.39 miles of track; an increase of 116.42 miles of road and 270.62 miles of track in 1886. Of these lines 4,415.44 miles were included in the Eastern system, east of Pittsburgh and Erie, and 3,249.93 miles were west of Pittsburgh.

The Eames Vacuum Brake Company; Freight Brake Catalogue. Issued by the Company; office in Boston, works at Watertown, N. Y.

Descriptive Catalogue of Railroad Switches, Frogs, Crossings, etc.; Pennsylvania Steel Company. Steelton, Pa.

Bolts, Nuts, and Screws: Trump Brothers Machine Company. Wilmington, Del.

OBITUARY.

Mr. Peter Emslie, who died in Buffalo, N, Y., May 8, aged 72 years, was a civil engineer who was for many years connected with the Lake Shore & Michigan Southern road. He designed some very fine masonry structures —culverts and bridges—for the road, and was very much interested in this branch of his work. Some years ago he had charge of the building of the State Insane Asylum at Buffalo. He retired from active work a few years ago.

Proffessor William Ashburner, who died in San Francisco, April 20, was a mining engineer of high standing and wide reputation. He was born in Stockbridge Mass., in 1831, and after the usual school course, passed two years in the Lawrence Scientific School of Harvard College and three years at the Ecole des Mines in Paris, where he graduated in 1854. On returning to this country he devoted some time to an examination of the Lake

Superior mineral region. In 1859, he was engaged in some explorations in the island of Newfoundland. In 1860, he went to California as assistant to Professor J. D. Whitney, Director of the State Geological Survey. From 1862 to 1883 he was engaged as a consulting mining engineer, his work taking him not only to various parts of the United States, but to British Columbia, Mexico, South America and even to Asia. In 1874 he was made Professor of Mining in the University of California, and subsequently Honorary Professor. He held various offices of trust in California, having served as Commissioner of the Yosemite Valley, Regent of the University, a trustee of the School of Mechanical Arts and a trustee of the new Stanford University. He was an active member of the California Academy of Sciences and of other technical societies on the Pacific Coast, and had many friends.

MR. FRANKLIN A. COMLY, for many years prominent in Philadelphia from his control of extensive coal and iron interests, died at his home, at Fort Washington, Pa., April 23. He was born in 1813 on the Pennypack at the place now as known as Bethayres, his parents being members of the Society of Friends. After passing through the schools in the vicinity he received a higher education in an academy in Philadelphia, and then went into the hardware business, first as a clerk and afterward as a partner of the old house of Parrish & Co In 1844, Mr. Comly became connected with the mining and shipping of coal, and was elected President of the Buck Mountain Coal Company, whose mines were situated in what is now Carbon County, Pa. In January, 1857, he was chosen President of the North Pennsylvania Railroad Company, as the successor of the late Hon. John Welsh, and has filled the office ever since. He was also President of the Longdale Iron Company, of Virginia, and of the Quinnimont Coal & Iron Company, of West Virginia; Treasurer of the Andover Iron Company, of Phillipsburg, N. J., of which he was one of the incorporators, and director of the Glendon Iron Company, of Easton, Pa.; the Allentown Rolling Mills; the East Broad Top Railroad Company; the Cranberry Iron & Coal Company, of North Carolina; the East Tennessee & Western North Carolina Railroad Company; the Hibernia Mine Railroad Company; the Pennsylvania Fire Insurance Company; the Long Branch Railroad Company; the Northeast Pennsylvania Railroad Company, and the Delaware & Bound Brook Railroad Company. He was also formerly a director of the Philadelphia & Reading and the New Jersey Central railroads. The deceased was unmarried; he leaves a considerable estate.

W. C. DEPAUW, one of the best known manufacturers in the West, died in Chicago, May 5, having been stricken with apoplexy while visiting that city on business. Mr. DePauw was a resident of New Albany, Ind., whose manufacturing industries were largely built up by him. He was born at Salem, Ind., in 1821. His father was not able to give his son much of a start in life, however, but left him to become the architect of his own fortune. In 1844, when he was a poor man, he was elected Clerk of the Courts of Washington County, and from his savings in office he laid the foundations of his wealth. He entered the banking business in 1854 and became President of the Bank of Salem. In 1861 he removed to New Albany, and became one of the heaviest contractors for army supplies in the West. He erected the large plate-glass factory at New Albany, and under most discouraging circumstances succeeded in establishing the business, which was new in this country, on a firm basis. Subsequently he became interested in the New Albany Rail Mill Company and the Ohio Falls Iron Works, as well as in woolen and cotton mills, foundries and other manufactories at that point, at Louisville and at Indianapolis, being a large stockholder in the Indianapolis Rolling Mill Company. He continued his connections with the banking business, and at his death was interested in a number of banks in Indiana and at Louisville and Chicago. Born and reared in Indiana, and residing there during the whole of his life, he was probably its wealthiest citizen when he died. He was also its most liberal citizen, having given large sums in charity and for religious and educational purposes. His donations to the Methodist Church amount to $1,000,000, and his will provides for a bequest of not less than $1,500,000 to De Pauw University, at Greencastle, Ind., to which institution he had already given over $300,000. His sons, who will have the management of his large estate, have been carefully trained to business.

Contributions.

Admirable Railroading.

To the Editor of the Railroad and Engineering Journal:

AN observer who can appreciate the difficulties which have to be surmounted in order to make two trains starting from different places reach a common center at almost exactly the same moment of time, and roll into a depot side by side, cannot but be impressed with the accuracy and precision which characterizes the operation of the trains on some of our great railroad systems. The writer was so impressed with the exactness of time of two trains, starting from widely divergent points, and yet reaching their destination at the same time with an accuracy bordering almost on perfection, that he cannot help but give it for the benefit of the readers of the JOURNAL. This occurred on Sunday, May 22, when the Little Miami train, which leaves Louisville, Ky., by the Louisville & Nashville, at 2:30 A. M., and the train leaving St. Louis, by the Vandalia Line, at 8 P. M. the night before, entered the arches of the Union Depot, in Columbus, O., with the points of their pilots not more than 15 in. apart. To see these two trains with engines of the same class, cars of the same kind and both arriving at the same time, is indeed a thing that must be admired by any one who can appreciate and realize what a grand thing railroading is at this time. These trains, with their sleeping and parlor cars, are consolidated into one train and run on to their destination, which is New York.

OBSERVER.

GEODETIC WORK IN THE UNITED STATES.

IV. THE U. S. COAST AND GEODETIC SURVEY.

BY PROF. J. HOWARD GORE.

AS the ideas of a people, as well as those of an individual, are strengthened and improved by contact and association, each nation has advanced and enlarged its interests by communication with other nations, or dwarfed them by confinement, so that one might take, as the exponent of a nation's prosperity, the amount of wealth that is going to and fro on its high seas. And though for many years after the arrival of the first settlers in America the attention of her people was feverishly directed toward the discovery and development of her resources, still the dependence upon the parent lands for those articles which the new enterprises failed to supply, the alluring call for recruits and their prompt responses, were such as to put into action a maritime intercourse that has grown with each passing year. And, while growing, the shores which bound our most frequented ports were again and again strewn with wrecks—each a sad commentary upon the ignorance regarding the shoals, reefs and dangerous shore-lines. In order to diminish the dangers to which a ship and her cargo are subjected, every Euro-

pean country having a foreign commerce at stake has instituted an accurate survey and delineation of its entire ocean boundary, not only as to its apparent outline, but also as to the character of the soundings leading into deep water. Although the successful prosecution of such works involve enormous outlays, still the assuring thought comes that the loss of all the vessels bound for a single port within one year would more than balance the entire expense.

The first appeal to our general government for assistance in carrying on a survey of the coast came from Messrs. Parker, Hopkins and Meers, who, in the latter part of the past century, made the necessary observations and examinations, and collected all the data requisite for a chart of the coast of Georgia, from St. Marys to Savannah, together with its harbors, rivers and inland navigation. In doing this, they exhausted their resources; they then petitioned Congress to appropriate $3,oco to enable them to engrave their charts. This petition was referred to a committee who, in a report submitted February 27, 1795, expressed an opinion favoring the work in general, but without a promise of the acceptance of this special proposition. The conclusion of this report was a series of resolutions, the first being: "That the President of the United States be requested to obtain, as soon as possible, complete charts made out from actual survey and observation of the sea coast, from St. Mary's River, in Georgia, to Chesapeake Bay, inclusive, and that——dollars be appropriated for that purpose." The other resolutions suggested that the work be done State by State, that results already collected might be purchased, that revenue cutters be employed as far as possible, etc. This report was referred to another committee, who made a report, on December 29 of the same year, which was almost identical with the first as to preamble and the first resolution quoted above, but nothing further was recommended as to the ways and means by which the survey was to be prosecuted. These memorialists, either because of their interest in the work or their desire to be reimbursed for the outlay they had already made, were not discouraged at the failures so far experienced, but secured further consideration of their petition, this time by the Committee on Commerce and Manufactures. This committee, on May 14, 1796, recommended: "That the President of the United States be requested to procure such accurate charts of the Atlantic coast of the United States, including the bays, sounds, harbors and inlets thereof, as have been made from actual observation and survey; and that, in all those parts of which no actual survey has been made, or where the same, in his opinion, be inaccurately done, he be requested to employ proper persons to survey and lay down the same, and to order the revenue cutters of the United States on that service, whenever, in his judgment, it can, without inconvenience to the public, be done." There was another resolution providing that, whenever the work of any person or persons was accepted, compensation should be tendered, together with the right and privilege that the maker publish the charts and hold the copyright to them. Although this method of carrying on the survey of the coast was never put into practice, nor Messrs. Parker, Hopkins and Meers ever recompensed for the work they did, this petition was unquestionably the first public expression of the needs for a coast survey.

The next step taken in this direction was the outcome of a suggestion of the Committee on Commerce and Manufactures, in its report made February 27, 1806, upon the expediency of making a survey of the shoals of Cape Hatteras, Cape Lookout and the Frying Pan. The significant clause was: "The Committee are fully apprised of the importance of having accurate surveys of the whole American coast, and they ardently hope that Congress will, at the next session, direct a complete examination to be made of it, from the St. Croix to the Mississippi, and to the extreme southwestern part of Louisiana in the Gulf of Mexico, including all our valuable harbors, bays and inlets, and we ought not any longer to rely on foreign charts for a knowledge of our own coast, when errors and omissions of great magnitude are known to exist in by far the greater part of them; and when, too, it is considered that corrections are seldom made in the American copies, it is presumed that there can be no doubt of the propriety of directing the earliest attention to this interesting subject."

This report also embodied provisions for completing a survey of the coast of North Carolina. Two Commissioners, Thomas Coles and Jonathan Price, were appointed for this undertaking—completing it during the following summer. In submitting their report to Congress, Mr. Gallatin, then Secretary of the Treasury, spoke of their chart as being more correct than any extant. The methods employed in this, the first hydrographic work, present a striking contrast to those of the present day. It appears that astronomic observations were made at only three stations; longitude was determined from lunar-distance observations, while the way in which they observed for latitude is not given. A large number of soundings were taken, though nothing is said regarding the plan adopted for locating the points at which they were made. Here and there, the directions to headlands are stated, but without any information as to the details of their operations.

This much space has been given to the antecedents of the Coast Survey in order that it may be clearly understood to what extent it was indebted to them. Up to this time, no attention was paid to the location of points trigonometrically, so the person who first suggested this plan is the one whom we must thank for the conception of a method which has, in its subsequent elaboration, reflected so much credit upon his followers. Just who this person is it is difficult to say, but the general impression is that it was Robert Patterson, at that time Director of the Mint at Philadelphia. Being acquainted with President Jefferson and the members of his Cabinet, he had free access to them; this, added to Jefferson's enthusiastic interest in all scientific matters, made it an easy task to secure at least a consideration of such projects as he might make. At all events, the act of Congress of February 10, 1807, was passed upon the recommendation of the executive. It appropriated $50,000 "For making complete charts of our coast, with the adjacent shoals and soundings," The best means of putting the act into effect was not at once apparent to the President, nor to his Secretary of the Treasury, Mr. Gallatin. So the latter, under date of March 25, 1807, issued a circular setting forth a project of a survey and requesting outlines of such a plan as might unite correctness and practicability. According to the scheme sent, the operations were distributed under three distinct divisions:

1. "The ascertainment by a series of astronomic obser-

vations the true position of a few remarkable points on the coast; and some of the light-houses placed on the principal capes or at the entrance of the principal harbors, appear to be the most eligible places for that purpose, as being objects particularly interesting to navigators, visible at a great distance, and generally erected on the spots on which similar buildings will be continued so long as navigation exists.

2. "A trigonometric survey of the coast between those points of which the position shall have been astronomically ascertained: in the execution of which survey, the position of every distinguishable permanent object should be carefully designated, and temporary beacons be erected at proper distances on those parts of the coast on which such objects are rarely found.

3. "A nautical survey of the shoals and soundings off the coast, of which the trigonometrical survey of the coast itself and the ascertained positions of the light-houses and other distinguishable objects would be the bases, and which would, therefore, depend but little on any astronomical observations made on board the vessels employed on that part of the work.

The circular also requested the names of such persons as could be recommended as capable of acting in the different parts of the work. They were sent to Robert Patterson, Andrew Ellicott, Secretary of the Land Office of Pennsylvania, Mr. F. R. Hassler, then in Philadelphia, John Garnett, of New Jersey, Isaac Briggs, of Maryland, James Madison, President of William and Mary College, and Joshua Moore, of the Treasury Department. The replies of these gentlemen give the best possible insight attainable into the condition of applied mathematics of that time. As a rule they advocated the determination of longitudes by finding local time from equal altitude observations upon the sun, and comparing this time with a chronometer set to the time of some known meridian after allowing for rate. It was thought that this method would secure results correct within two seconds of time. Latitudes were to be determined from meridian-altitude observations on the pole star, the error to be feared falling within 10″ or 15.″ The instrument suggested was a sextant or a whole circle of Borda. It was thought that 30 points so located along the entire coast would be sufficient, with, perhaps, the position of a few intermediate stations determined by rockets, powder-flashes or balloons. The triangulation was a feature that taxed their ingenuity, because they appreciated the difficulties that would attend such a work through a low, wooded country such as prevailed along the coast. The accuracy the most hopeful thought attainable was within 30″ for each angle, which, he said, allowing for the errors in determining the position of the initial point, and supposing the base-line to be correct, would, in a distance of 1,000 miles, about the length of our coast, give an error of only 660 ft.

The matter of instruments was also an important item, and one about which the majority of those consulted knew but little. However, one ventured to give a list, together with the probable cost of each; the whole amounting to a little more than $4,000, including a base apparatus which was to cost $50.

The above is a digest of the plans outlined by the Americans who were consulted, while the response of Mr. Hassler gives a scheme in which theory had been strengthened by practice. Mr. Hassler came to this country in 1805, fresh from geodetic work, having been engaged in the triangulation of the Swiss canton of Berne, and later enjoyed the rare privilege of working with Bohnenberger in Austria. He brought with him a rich experience, a valuable collection of instruments and a library of scientific works which, Garnett said, was the best in this country. This, added to a desire to lend his assistance to every worthy undertaking in his line, placed him in a position to make suggestions that must, of necessity, be inestimable in the organization and execution of such an important work. He proposed that there be measured, upon the whole extent of the coast, with a "*cercle repététeur à deux lunettes,*" 1 ft. diameter, or, with an English theodolite of at least the same diameter and capable of multiplying angles, a chain of triangles, the sides of which should be about 60,000 or 100,000 ft., and established upon bases measured with the known means of exactness.

All the astronomical observations and deductions which circumstances may require, or which may be necessary, ought to be made in the course of the work at convenient points, as well for determining the latitude and longitude of those points, as the azimuths of the sides of the triangles. At the same time, as many secondary points and even simple directions ought to be ascertained as can be effected without impeding the principal design. In this way fixing the situation of light-houses, towns, villages and other important points on the coast which would serve for the continuation of the surveys in detail. The results should be laid down according to the differences of the meridians and parallels upon large paper divided into sections for convenience, and accompanied with a table of longitudes, latitudes, distances and azimuths.

The manner of keeping the record, taking soundings and making the astronomical observations was discussed quite freely. He proposed to use for a signal a triangular pyramid of from 10 to 30 ft. in height, from which a strong pole should proceed bearing a ball of 1 ft. in diameter, composed of potters' clay and covered with a good yellow varnish, forming a point of reflection, or a globe of 1½ or 2 ft. in diameter, formed of barrel hoops, covered with white or black cloth, according as the projection, in relation to the observer, falls upon the surface of the earth, in the sky or in the water. For night signals large argand lamps with wicks of 6 in. or more in diameter should be fixed upon the stations.

The plats above referred to were to be given to those who were charged with the detail survey, who should take the given points as bases, from which to fill up their portions of the survey as fully as may be desired, either with a small theodolite, a "planchette," a kind of plane table, sextant or compass, according to the accuracy and amount of detail necessary.

For off-shore work, he considered the three-point method unsafe, and advised the employment of two observers, one on land at a known station and the other on the boat, each of whom, at the time of sounding, should read the angle between the other and a second visible point.

The various plans were referred to a commission consisting of Messrs. Patterson, Briggs and Hassler, who, after giving each due consideration, agreed that they should recommend to the President the scheme of Mr. Hassler.

THE MILLER PLATFORM AND COUPLER PATENTS.

In February last, a suit of the heirs of the late Ezra Miller, against the Pennsylvania Railroad for infringement of his patents, was tried in the United States Circuit Court, in New York City.

As this case is an interesting one, it is now proposed to give a short history of it.

At the outset a brief history of the litigation will be given, and then the mechanical features of the case will be explained.

The Pennsylvania Railroad Company had been using the link-and-pin coupler and was desirous of getting a good coupling system for the road. In 1876 or 1877, Mr. Eli H. Janney brought to the attention of the officials of the road his coupler. This device was at that time not combined with any buffing system, other than that furnished by the couplings themselves. A number of cars were fitted with Mr. Janney's couplings, and much experimenting was done. After a time, this coupler having been adopted, it was determined to adopt a buffing system, which involved the use of the buffers, patented to Cummings, Patent No. 192,570, dated July 3, 1877. Just what the arrangement was will be spoken of later on, and drawings will be introduced illustrating the device in full.

Apparently, when the officials of the Pennsylvania Railroad Company had decided that the Janney devices were satisfactory to them, they proceeded to see whether in using them they would be infringing anybody's patents.

The Eastern Railroad Association is specially organized to meet such cases, and to this organization the road applied. The inquiry of the road was considered by the Association at the December meeting of 1877; it was sent to a committee and came up for final action in May, 1878.

The report of the committee was rendered after communication with Mr. Ezra Miller, the inventor of the Miller system of buffers and couplers. In the original request presented by the Pennsylvania Railroad Company to the Association, the following patents were cited: Patents Nos. 39,436, 138,405, 156,024, for improvements in car couplings, and also Patents No. 39,436. dated August 4, 1863, granted to Hazen Webster, and No. 192,570, granted to Cummings.

The specifications of the various patents and the drawings were annexed to the letter of inquiry. The patents submitted were those of Janney, Cummings and Webster.

The Committee after referring the matter to Col. Miller got from him the following letter:

"*New York, April 12, 1878.*

"*S. M. Whipple, Esq.,*
General Agent Eastern Railroad Association.
"*Dear Sir:*

"I have looked over the Janney patent papers, including patents No. 138,405, dated April 9, 1873, No. 156,024, dated October 20, 1874 and Webster, No. 39,436, dated August 4, 1863, and Cummings No. 192,570, dated July 3, 1877, and I am of opinion that they do not either of them infringe or at all interfere with my patents of March 31, 1863, and No. 38,057 January 31, 1865, and No. 46,126, and No. 56,594 of July, 1866.

"Your friend,

"E. MILLER."

After this letter from Miller to the Eastern Railroad Association, the Pennsylvania Railroad Company felt that it had a right to go ahead and use the devices, which it had taken the trouble to ask about so carefully.

Some time elapsed, and the Company had a number of the Janney devices in use, when it appears that Miller changed his mind partly and wrote another letter to the Eastern Association taking back in part what he had said in his previous letter and suggesting that as the devices were used upon the cars of the Pennsylvania Railroad Company's lines that he should be paid something. This letter seemed to indicate that the devices as used were not the same in Miller's estimation as those which had been submitted to him in the letter which the Eastern Railroad Association had sent him when asking his opinion previously. Miller never changed his views as to his 1863 patent. However, this letter was addressed to the Eastern Railroad Association and not to the Pennsylvania Railroad Company. The Association never transmitted the letter or a copy to the Pennsylvania Railroad Company, as this was no part of the regular business. As a result the Pennsylvania Railroad Company never knew anything about the letter and went along using the Janney devices in ignorance of the fact that Miller had changed his mind partly and now thought that some of his patents were infringed.

The next thing the Pennsylvania Railroad Company knew, it was sued by Miller under his three patents for infringing certain claims of each patent.

Miller brought the suit in 1883, and as, by this time, each of his patents had expired, he was forced to bring the case on the law side of the Court, which necessarily brought it before a jury. Had the patents been in force when the suit was brought the case would of course have been brought on the equity side of the Court, and the testimony would have been taken before an examiner, and the case would have been tried before a judge without a jury.

The case was called on February 1, 1887, before Judge Alfred C. Cox and a jury, and the trial was then proceeded with and lasted nine days. During the time that the case was reaching a hearing, however, Miller died, and it was proceeded with by his heirs.

The suit was founded upon the three patents of Miller, which are dated as follows: March 31, 1863, No. 38,057; January 31, 1865, No. 46,126; July 24, 1866, No. 56,594.

The patents had many claims, but certain ones were selected and pressed in the trial. The claims that the plaintiffs started in with were the following: In the case of the first patent, Claim 4; in the case of the second patent, Claims 1 and 4; and in the case of the third patent, Claims 1 and 3. During the course of the trial some of the claims were dropped or no testimony taken regarding them, as follows: Claim 1 of the second patent and Claim 1 of the third patent.

In this part of the article it is not intended that the mechanical features of the case should be dwelt on at length, and it is scarcely to be supposed that the legal aspect of the case would be of much interest to the readers of a mechanical paper, consequently as brief a statement of the trial will be given as will serve to give a clear idea of what took place.

The complainants (Miller's heirs) opened their case and proved infringement of the claims before referred to, excepting Claim 1 of the 1865 patent.

The defendant (the Pennsylvania Railroad Company) then proceeded with the testimony, in the case of some of the claims denying the infringement, and in the case of others insisting that the inventions were not new, or were not patentable. Later on these several claims will be specifically dealt with and considered. During the taking of the testimony the Miller side gave evidence of an

established license fee having been paid for the use of the three Miller patents as a whole. No license fee was shown to have been paid for any one or two of the Miller patents, but always for the use of the three patents, including all the several claims of each patent. This license fee was nominally $100 per car. Ezra Miller's son testified on the trial that, in about the case of 500 licenses, the amount per car came up to about $53. As the period during which the Pennsylvania Railroad Company was alleged to infringe the Miller patents extended from 1878 to 1883 it became a question as to what the license fee per car was during this period. A book of licenses was produced, covering the time of the alleged infringement by the Company. From this book it was difficult to deduce anything, but it appeared to show a license fee per car of about $25. This amount could not be clearly ascertained, as in most cases a lump sum was taken and this might have included 1 or 50 cars. In no case was there a license for anything except the use of all the three patents conjointly, embracing all that was covered by them. As the case went on, the claims, as above noted, were withdrawn, but this withdrawal of claims still left a claim of each of the three patents infringed. At the end of the taking of testimony, counsel for the defendant made a motion to dismiss the suit.

The only part of this which it is important here to dwell upon is as follows: It was asked, among other things, by counsel for the Pennsylvania Railroad Company, that the suit, so far as it related to the fourth claim of the 1863 patent, be dismissed, because on the face of the patent the claim was limited to a specific form of coupling head which the defendant did not have. This was a question of law and not of fact for the jury.

The Court, in this matter, held with the defendant that the fourth claim of the 1863 patent was not on its face infringed. This view, taken by the Court, left the complainants with only two patents in controversy. The Court further intimated that in the charge to the jury it would be necessary to tell them that the fourth claim of the 1865 patent could not be so construed as to make it for an invention which in any way differed from the earlier structures which the defendant had proved existed. If this had been charged, and had the case gone to the jury, then the complainants would have had only a single patent practically in controversy.

At this stage of the case counsel for the defendant called attention to the fact that where a license fee had always been paid for the use of the inventions of a number of patents, in a suit upon these patents, if all were not infringed, unless evidence was given of the value of the patents separately, only a verdict of 6 cents could be recovered.

Now, the Miller side, practically, had only one patent left in controversy, one being taken out by the Court, and the second likely to be practically taken out by the judge's charge when it came. No testimony had been given by the complainants as to the value of the patents separately, and, with this state of facts, and with the law as it applied to the case, the Judge announced to counsel that he would be forced to charge that the complainants could only have 6 cents damages at best.

After a careful consideration of the state of the case by counsel on both sides, it was determined by counsel for the defendant, the Pennsylvania Railroad Company, to accept a verdict of 6 cents as against the company. This he did because it saved a tedious summing up of the case, relieved the jury of two days' work and practically made the company a victor, for, as the patents had expired, the fact that the decision was for the complainants was not followed by an injunction, but left the road free to use the couplings and buffers which were upon its cars.

Before quitting the subject, there is one further fact to be noted regarding the fourth claim of the 1863 patent. When the devices used by the Pennsylvania Railroad Company were submitted to Miller as before noted, he gave the answer above quoted. After a time he took back his opinion in part. This change of view on his part. though it may have affected the 1865 and the 1866 patents, did not affect or include the 1863 patent, and, therefore, the Court held that the fourth claim of this patent was not infringed on its face, and that also the complainants were estopped, by Miller's own act, from saying that it was infringed. Even if Miller could have risen from the grave and have been put upon the witness stand, he himself could not have denied the fact that he had said that this claim was not infringed and that from this opinion he had never varied and could not now alter it.

These facts as to the litigation itself, may not seem of much interest to readers who are chiefly interested in the mechanical features of the case. However, without a comprehension of the facts as above stated, no true understanding of the matter can be had even, in its mechanical relations.

Before proceeding further, therefore, it is best that a clear understanding of the Janney coupler and buffer should be had. It was at first thought that the coupler alone, which can act as a buffer, would be sufficient. But later on it was determined that some form of seperate buffer had better be adopted. The object was to obtain a buffer which would check, in as great a measure as possible, the oscillation of the cars about an imaginary line passing through the center of the car-beds. This motion was not efficiently checked by the Miller buffer located in the axis of the motion, for, with such a buffer, the heads of the buffers merely rotate on each other, and the consequent friction is small. After considering the matter, Mr. Ely, General Superintendent of Motive Power of the Pennsylvania Railroad, partly matured a plan involving the use of the two side-buffers now employed in the Janney system. He had not time to work the matter out, and therefore turned the crude idea over to Mr. Janney, who perfected the mechanism necessary to the carrying out of Mr. Ely's ideas.

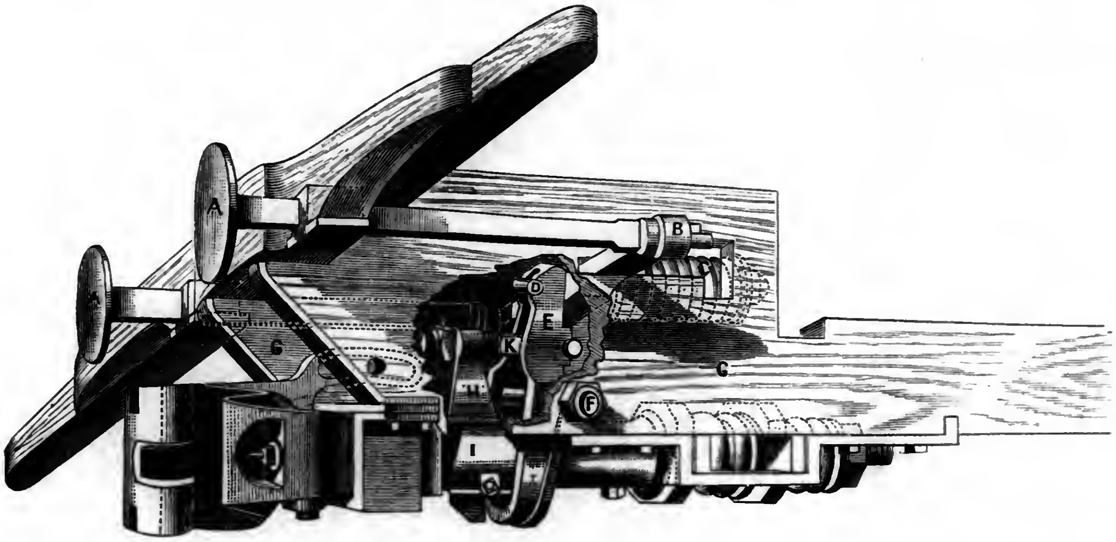
Among the requisites demanded by Mr. Ely was the following: That when the cars were coupled the engineman should not have to overcome the full force of the buffer spring to get the draw-faces of the coupling hooks together, while, at the same time, when in draft or compression, the buffers should, through the action of the couplers, exert an increased effect upon each opposite buffer.

Besides this it was also required that the buffers should be side and not central or axial buffers, so that when the cars oscillated the motion would be resisted by *metallic surfaces sliding past one another* under pressure, rather than, as in the Miller, by having surfaces which merely rotated upon each other. The first form of arrangement of parts presented a much greater resistance to oscillation than could be obtained by the Miller system or by any system

involving the use of buffers located at the center of the car or in the axial line of the car's oscillation.

These were the ideas, and they were embodied in practical shape by Janney in the following mechanical arrangement:

The first cut represents the Janney car coupler and buffer for passenger cars, and is shown as attached to the platform, a portion of the knees being cut away to show the workings of the apparatus.



The coupling being made between two cars, equipped as above, the faces of the side buffers *AA* are brought in contact with those upon the opposite car, and the thrust is communicated through the equalizing bar *B* to the buffer spring *C*, which is secured by means of a T-bolt, *D*, to the yoke *E*, which yoke is pivoted by means of a pivot bolt, *F*, passing through the platform knees *GG*.

The action of the yoke *E*, is peculiar, as, by its means, the buffers are thrust toward the pair upon the opposite car, whether *in the operation of coupling, or while the train is in draft.*

In the act of coupling, the natural tendency is to drive the coupling inward; when this inward movement takes place, the lower end of horn *H*, which passes vertically through the body of the coupler *I*, engages with the lower end of the yoke-lever *E*, and in throwing that end *backward* throws the upper end *forward*, hinging upon the pivot bolt *F;* the yoke carries forward with it, by means of the T-bolt *D*, the spring *C*, which, in turn, through the equalizing bar *B*, communicates the same forward motion to the buffers *AA*.

When the train is in *draft*, precisely the same action of buffers is obtained by the upper end of the horn *H* moving with the coupler and carrying yoke *E* forward by means of the T-bolt *K*.

The T-bolt *K* passes freely *backward* through the yoke *E* when the *couplers* are in compression, thus permitting the work of throwing forward the buffers to be done by the *thrust* of lower end of horn *H;* but when the coupler *I*, moves *forward* the T-bolt *K* comes into action and *draws* upper end of yoke *E* forward, with the result as described, and which may be followed out by anyone who will give the above cut a little study.

The essential features of the *coupling* will be understood by reference to figs. 1, 2, 3 and 4, which represent the Janney freight coupler. Fig. 1 is a top view of the freight coupler, and represents the pair in proper position to effect the coupling, viz.: one hook closed and locked and one opened (both hooks may be open, but this is not necessary). Fig. 2 shows the coupling effected, and both hooks are locked as shown in fig. 3, which presents a section of the freight coupler when cut longitudinally, to show the method of locking the hooks by means of the gravity pin which drops in front of the point of hook, as shown in section. By a lift of this pin, which is effected by means of a lever at side of car, the point of the hook is freed when it is desired to uncouple, and when it is desired to

FIG. 1

FIG. 3

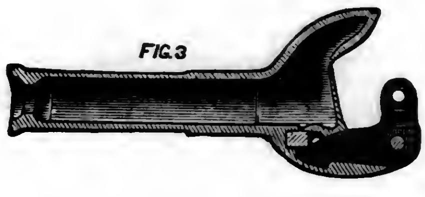
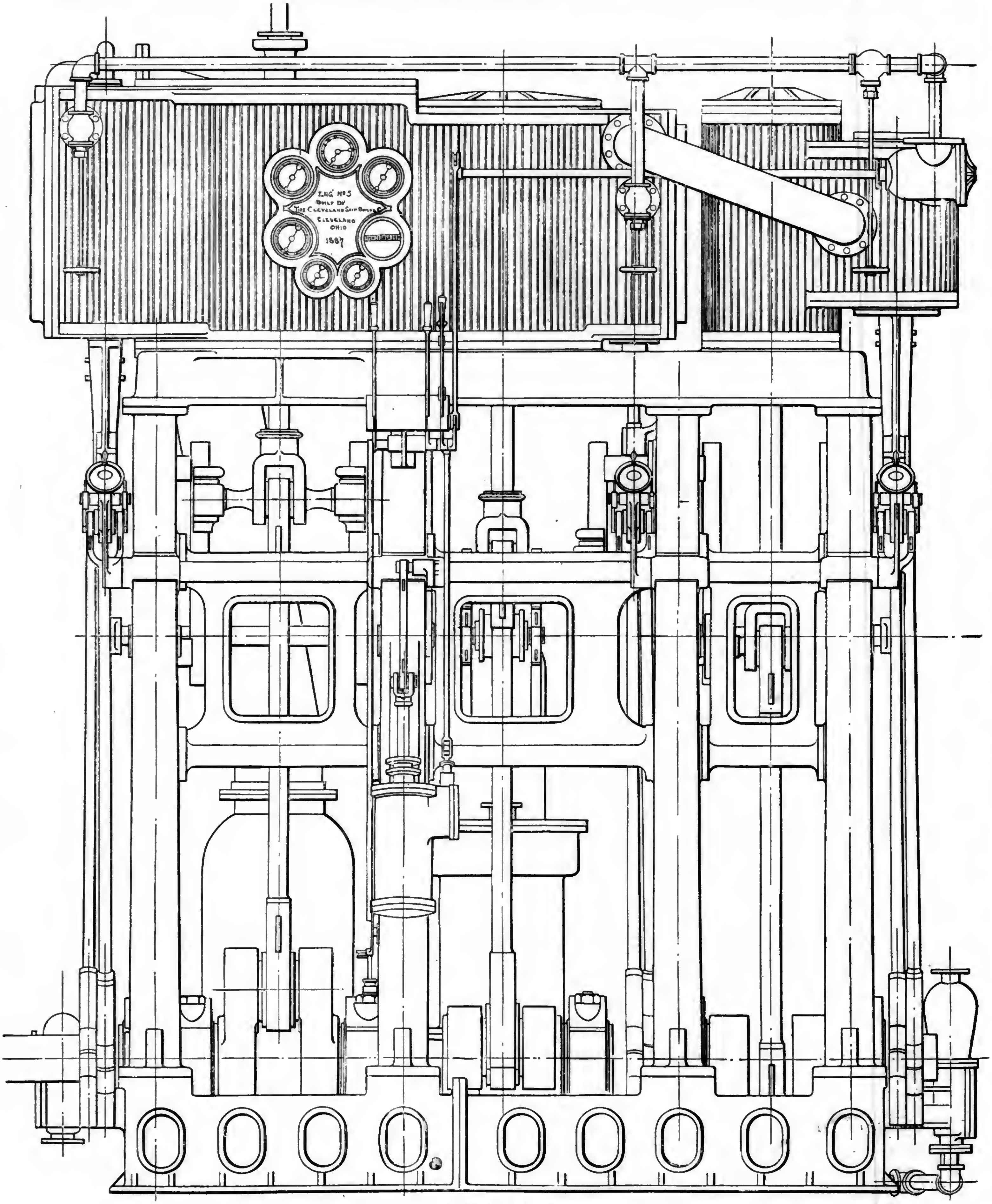


FIG. 2

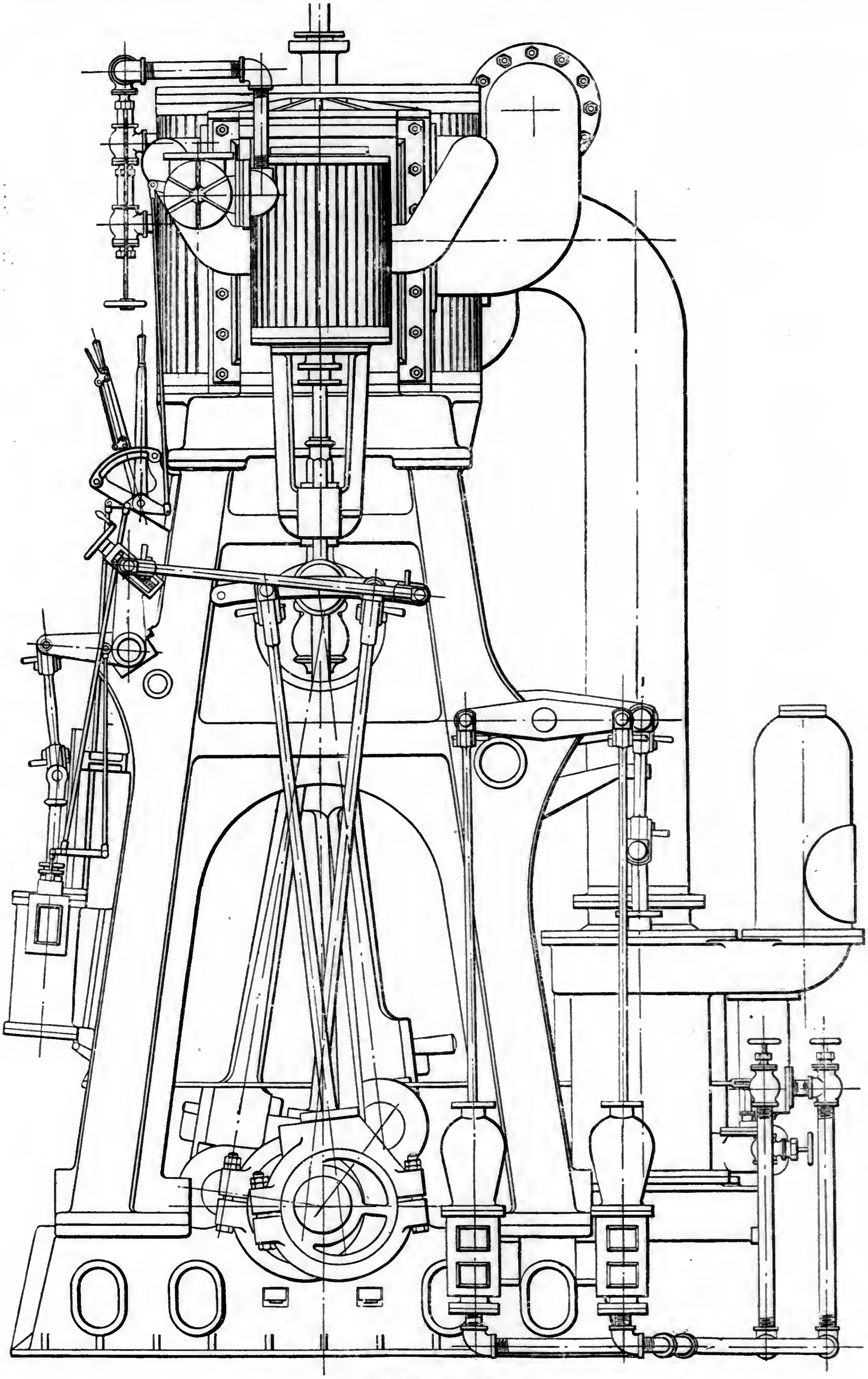
FIG. 4



SCALE, ⅜ IN. = 1 FT.

TRIPLE EXPANSION ENGINES FOR STEAMER "AURORA."

BUILT BY THE CLEVELAND SHIP-BUILDING COMPANY, CLEVELAND, OHIO.



SCALE, 3/8 IN. = 1 FT.

TRIPLE EXPANSION ENGINES FOR STEAMER "AURORA."

BUILT BY THE CLEVELAND SHIP-BUILDING COMPANY, CLEVELAND, OHIO.

run cars together (as upon a siding) without coupling, the gravity pin is secured in the open position, and the cars will not couple automatically until the pin is released.

The draft bolt connecting with the coupling makes a ball-and-socket joint, as will be observed by examination of fig. 3. Fig. 4 is a view in perspective of the coupling hook, and showing means of coupling with link and pin when brought in contact with that class of coupler.

Substantially this mechanism, as above described, was that which Miller brought his suit against.

In some cases the cars of the Pennsylvania Railroad used springs surrounding the buffer-shanks instead of using the single spring *C*, but this was the first arrangement and was probably suggested by the Cummings patent, and was soon abandoned for the structure shown in the above cut.

The Cummings patent first suggested the use of two side buffers with springs on the buffer-shanks and a pivoted equalizing lever or bar, *B*, between the two buffers, so that in rounding curves the pressure upon the springs would be equalized and would be brought to the center of the car.

This Cummings arrangement was used by some of the connecting lines of the Pennsylvania Railroad before the adoption of the Janney system, and, though used in a different way, was no doubt the germ of the idea which was developed in the Janney buffing system.

A careful reading of the foregoing, will show clearly what the Pennsylvania Railroad Company was using when Miller brought his suit.

One other point, however, is to be noted. When the Janney system, practically as above shown, was adopted, Mr. Ely insisted that, when the cars were at rest and in their normal position, the faces of the buffers should not be set further out than the faces of the draw-hooks. The object of this arrangement was to prevent a shock in coupling. No doubt this location of the parts was had upon the earlier cars, but subsequently it was modified so that the faces of the buffers *AA* projected beyond the draw-faces of the couplers an inch or less. This made coupling more difficult.

This arrangement was adopted because the rapid wear of the parts and the lost motion required it, and it was deemed best to suffer a slight disadvantage in the act of coupling, so as to ensure pressure at all times between the faces of the buffers upon any two cars.

Many cars will be found on the Pennsylvania Railroad to-day, however, having no protrusion of the buffer faces beyond the draw surfaces of the coupler, when the cars are at rest.

TRIPLE-EXPANSION MARINE ENGINE.

THE accompanying illustrations represent an engine of the triple-expansion pattern designed for the new steamship *Aurora*, intended for service on the great lakes, and owned by Messrs. John Corrigan, Captain Mack and others. The steamer and engine are built by the Cleveland Ship Building Company, of Cleveland, Ohio. The engines are of the triple-expansion, direct-acting, jet-condensing type, and are expected to work up to 1,800 indicated horse-power. The three cylinders are 24, 38 and 61 in. diameter, respectively, having a common stroke of 42 in. The bed plate is of deep box pattern, cast in two parts, with the joint running athwartship, and carries the five journals of the crank shaft, which is in five pieces with solid coupling between the intermediate and low pressure engines. The journals on this shaft are 12 in. in diameter The three crank pins are of mild steel, 11½ in. in diameter, with 10-in. bearings. The three cranks are all double throw, and are made of forged iron. The connecting rods are of forged iron with straps, gibbs and keys in each end. The slides are of mild steel, bolted to columns in the center line of the engine, fore and aft, except the forward slide of the intermediate engine, which is removed from the column far enough to admit the placing of

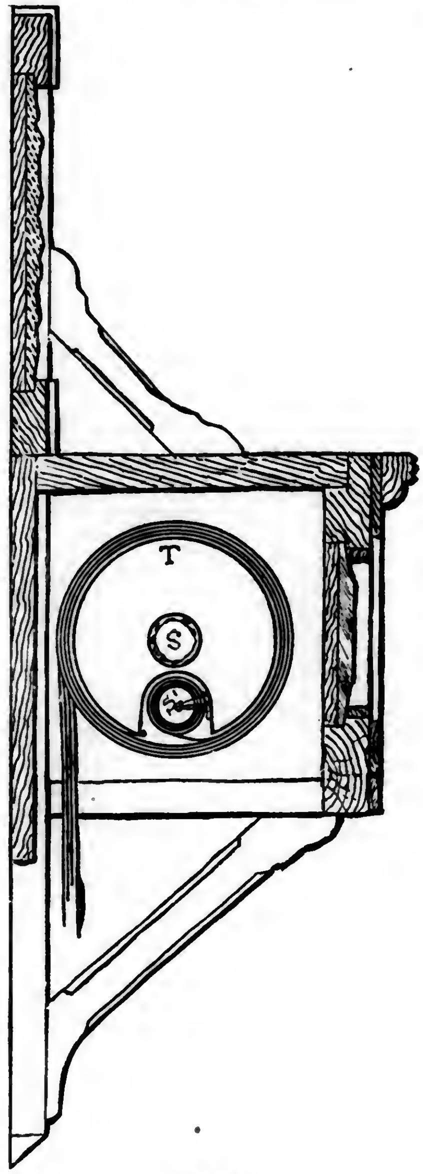


Fig. 2.
IMPROVED SCHEDULE CASE.

the link and connections between the slide and the column. The links for the first and third cylinders are placed outside the columns. The eight columns carrying the cylinders are of box section cast in pairs and bolted together through the fore-and-aft girts.

The small or high-pressure cylinder is fitted with a piston valve, and the other two cylinders—the intermediate and low-pressure—with slide valves, all being very easy of access for examination and repairs. The air pump is of the ordinary single-acting bucket arrangement, 28 in. in diameter and 17 in. stroke, and is so planned that any valve may be reached by taking off its cover. The condenser is of cast-iron, 35 in. in diameter and fitted with jet spray.

The propeller is four-bladed and is 13 ft. diameter and 17¼ ft. lead.

The engine is supplied with steam from two boilers of the Scotch type. Each boiler is 12 ft. diameter and 14 ft. long, and has three 40-in. furnaces. They are expected to carry a working pressure of 165 lbs. in service.

Improved Schedule Case.

THE subject of the accompanying sketch is a neat, cheap and serviceable device for keeping maps and schedules on file and within convenient reach. It consists principally of a wooden box without bottom, to which the wall-braces are securely attached. In this box there is placed, and provided with suitable end-bearings at each end, a hollow tin drum or cylinder marked *T*, to which the spiral spring *S* is fastened. The curtain or cover which is to act as a mantle to the maps and schedules when drawn down, is fastened directly to the spring-roller *S*. The schedules themselves are all clamped together and fastened to the back curtain, which, in turn, is attached to the roller before mentioned. The spring is so hung that when the schedules are all rolled up its tension will be at its minimum, while, by pulling down the curtain, it will be put under tension. The manner of operating is to pull down the outside curtain (which unrolls from the tin drum), then by holding fast the inside curtain which has the maps and schedules attached to it with one hand, and by giving the other a slight pull and releasing it, it will enter the groove and be out of the way when it is desired to refer to any map or schedule. In closing the arrangement up the outside curtain is again drawn down, and, by taking hold of the bottom of the inside curtain, by a slight lift, both it and the outside curtain will roll up around the tin cylinder. In hanging the schedules the vertical edge of each successive schedule is placed so as to overlap by about ¼ in. the similar edge of the preceding one, and in this way is formed an index which facilitates the finding of any particular map or schedule. This takes the place of large canopies, where sometimes from 12 to 20 or more rollers are used for maps, which is a bulky and inconvenient arrangement.

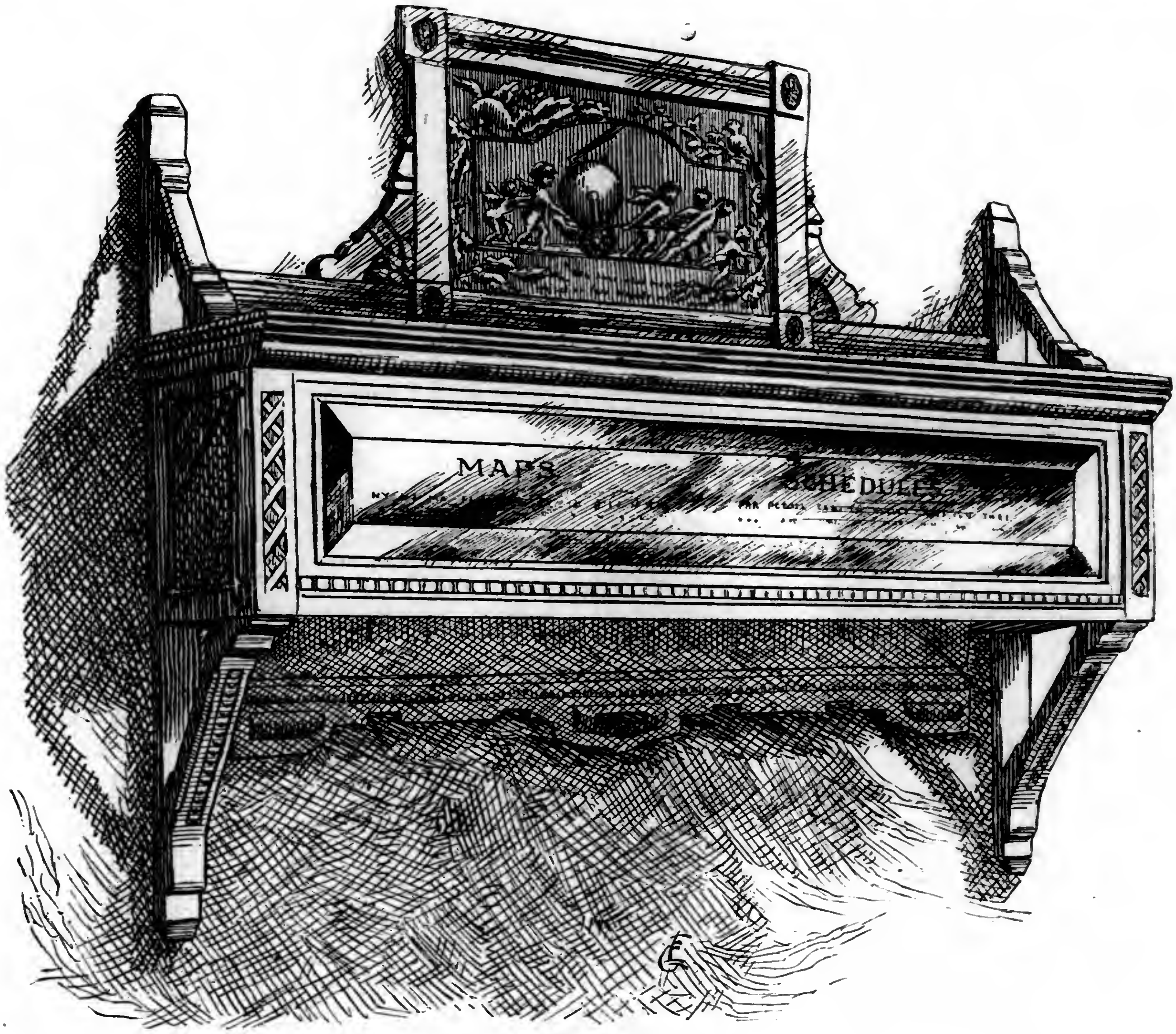


Fig. 1.

IMPROVED SCHEDULE CASE.

Mr. Berry, General Superintendent of the Pullman Company has one which holds 83 schedules. Most of the general offices of the Pittsburgh, Cincinnati & St. Louis system are provided with this improved schedule

case, and have the same in active and successful operation. An arrangement, with clock, air-gauges and indicator attached, for private cars has also been used; these gauges show the pressure in the main-brake pipe and cylinder, besides being a means for applying brakes and "bleeding" the cylinders when necessary to do so. The whole contrivance is beautifully and appropriately enhanced by the addition of wood carving and by putting in a bronze bas-relief.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILWAYS.

THE British Board of Trade is authorized to make investigations into the causes of all important railway accidents which occur in the United Kingdom. Competent inspectors are employed for this work, and, as the system of rotation in office does not prevail in the civil service of that country, these inspectors, besides being qualified by education and training for this service, also acquire experience which fits them for making such investigations. Their reports now cover a period of about 35 years; they have been published and form quite a library of themselves, and are a mine of information about railroad management and of warning for the prevention of accidents. As these reports are inaccessible to most American railroad officers, and as they are so bulky that few could have either time or patience to go through them, it has been determined to make summaries of the reports of some classes of accidents which it is thought will be instructive and interesting to our readers. These investigations of the accidents on British railways, it must be remembered, have been made under authority of a law giving the inspectors full powers to ascertain all facts in each case, and hence are more complete than anything which can be looked for in this country, except in two or three States where railroad commissions exist with authority to investigate accidents. The English reports have also the advantage even then, from the fact that the inspectors, as noted above, are men whose time is almost entirely occupied in this work, and who are, consequently, trained experts, with an experience which a railroad commissioner rarely has the opportunity of acquiring in this country, where few are permitted to hold office a great while. As there has been much discussion over the comparative merits of American chilled car-wheels and English wrought-iron wheels with steel or iron tires, a record of the accidents on English railroads due to breakages of wheels or tires may be of service by way of comparison, and we present, accordingly, a brief statement of those accidents, beginning with 1853. This record has been carefully prepared from the inspectors' reports, and is intended to give the substance of those reports in a condensed form.

ACCIDENT REPORTS.

June 1, 1853, the engine of a passenger train on the Leeds Northern broke a tire on a leading wheel when near Wormald Green. The tire broke into three pieces and fell on the road-bed, a piece of it causing the brake-van, next the engine, to leave the rails and upset, killing the guard. The engine ran 1,050 ft. without leaving the rails. The leading wheel was 42 in. diameter, carrying about 3 tons weight. The tire was not much worn and had run 2,964 miles. The three pieces were 3 ft. 5 in., 1 ft. 10 in. and 5 ft. 2 in. long, respectively. The tire was of Lowmoor iron, shrunk on and fastened to the wheel by bolts. The Inspector finds that the weld was originally defective and one of the bolt-holes passed directly through it; one of the fractures, took place at this point, while the other was also at a bolt-hole. He recommends careful trying of the tires by tapping with a hammer.

August 22, 1853, a passenger train on the York & North Midland was derailed near Cottingham, and a third-class open carriage upset, killing two women. The derailed car was next the tender and ran about 1,200 ft. before the train was stopped. The derailment was caused by a broken iron tire on one of the wheels of the carriage. This tire broke at the weld, which seemed to have been an imperfect one, though fair on the original surface. It had been originally 1½ in. thick, but was worn down to ⅞ in.

January 12, 1854, a first-class carriage in an express train was derailed near Ambergate, Midland Railway, by the breaking of a tire on one of the leading wheels. The tire broke in two places, the weld remaining perfect; it was of good iron, from the works of the Patent Shaft Company, and but little worn. The weather was very cold, and the ground covered with snow. At about the point where the wheel first left the track a broken rail was found, but it was believed that this rail had been broken by the tire.

May 16, 1854, near Hornsey, on the Great Northern, rear brake-van of a passenger train was derailed, and the guard was thrown off and hurt. The tire of a wheel on the derailed van had broken and come off; it was found about ¾ mile back from the point where the train stopped. Traces were found showing that the tire had broken about two miles back; the injured guard said that he had tried to signal the engineman, but failed to attract his attention. The tire appeared to have broken at the weld, but the surface was so covered with dirt that the nature of the flaw could not be detected. The tire was iron, of good quality, made at the Lowmoor Works.

December 23, 1855, as a special express train was passing Swan Village station, Great Western Railway, the tire of the 6-ft. driving wheel of a standard-gauge engine broke, stripping the heads off eight of the rivets by which it was secured to the wheel, tearing up the station platform and fence, running across the highway and through another fence, and on its way killing a girl who stood in the road. Of this accident the Inspector says: "This accident appears to have been of an extraordinary nature, as the tire, with the exception of a single fracture, was found whole, but bent to the form of a cycloid. The fracture took place right across the tire and close to the weld, but not in the direction of the inserted V." The tire was made by Hood & Cooper, Leeds, and was of good fibrous iron, hard on the outer surface, and without any exterior indication of a small interior flaw existing at the point of fracture. It had run only about 2,000 miles.

January 21, 1855, a brake-van was derailed near Woodhead, on the Manchester, Sheffield & Lincolnshire line, and a guard badly hurt. It appears that a trailing wheel on a carriage in front of the van broke a tire; the wheel was broken to pieces and the axle torn from its place, and the broken wheel threw the van off. The tire (Lowmoor iron) was broken in two places, a piece 3 ft. in length being detached from the wheel altogether. The first break was at the weld, which showed a bad flaw in the center. The tire had been used six years, and was worn down to $1\frac{7}{16}$ in. thick on the tread.

February 19, 1855, a tire broke under a carriage of a passenger train on the Northeastern road, near Cramlington. The car was derailed, but ran nearly two miles before the engineman stopped the train. The guard saw the break at once, but had no way of signaling the engineman. The tire broke at the weld, where there was a large flaw in the center, the outside being perfect; it was of Lowmoor-iron, 2½ years in use. There was an opening of about 6 in. at the fracture, but the tire was not otherwise out of shape. The concussions following the break tore the leading axle from its place and the wheels and axles were thrown back against the trailing axle with such force as to tear it out from under the carriage, leaving it supported by the couplings alone.

February 20, 1855, as a passenger train on the South

Devon line was entering Brent station, a carriage left the rails but remained on the ties. The tire of a leading wheel broke at the weld, within an inch of one of the rivets holding it to the wheel-center. The broken end sprung out 5 or 6 in., but remained in contact with the wheel at the next rivet, 27 in. distant. The weld where the break took place was a jumped weld and very defective, though showing no flaw externally. The tire was Lowmoor iron, in use about two years.

February 22, 1855, at Four Ashes station, on London & Northwestern road, a goods wagon (freight car) was derailed by a broken tire. The tire was of iron, on a car belonging to the Newport, Abergavenny & Hereford Company, made for that road by Ashbury, Manchester. "The tire was fractured at the weld and was also split in a longitudinal and horizontal direction. It was composed of poor iron, badly forged and worse welded."

January 16, 1856, an express train on the Great Northern was derailed near Tallington, a first-class carriage being upset, injuring two passengers. A tire had broken at the weld; it was of Lowmoor iron, and had been twice turned off, the last turning leaving it 1⅛ in. thick.

December 3, 1856, tender of an express train was derailed near Thornhill Lees, Lancashire & Yorkshire Railway. Tire of a leading wheel broke and became loose from the center, jamming fast between the brake-block and the framing. From marks on the track it was thought that the tire broke at a bad rail-joint.

July 27, 1856, car of an express train on Newcastle & Carlisle line was derailed near Haltwhistle, 3 passengers being slightly hurt. The derailment was caused by the tire breaking at the weld; after the first break it seems to have broken into several pieces, which were scattered along the line. The tire was of iron from the Walker Iron Works; it was 1½ in. thick originally, but had been worn down to 1¼ in.

May 11, 1857, a four-wheeled fish truck in a mixed train on the Great Northern line was derailed near Barnet station. The coupling broke and the forward part of the train went on, but nearly all the cars behind the derailed truck left the track. A broken tire on a leading wheel caused the damage; it broke in five nearly equal pieces, through the rivet holes. One piece showed an old flaw, and the metal generally was much crystallized, having the appearance of poor iron.

May 1, 1858, a passenger train on the Manchester, Sheffield & Lincolnshire road was derailed near Oxspring by a broken tire on a trailing wheel of a passenger carriage. Three cars went off and were badly wrecked, after running some 1,200 ft. on the ties. It appears that a short piece of the tire broke out and was thrown off the wheel altogether; this was followed by a second and a third piece, and the third piece was thrown over on the opposite rail, striking the other wheel and causing the tire on that to break also. The tires were of iron, from the Blaenavon Works, and the Inspector reports that they were probably of poor iron originally, and had been rendered brittle by too sudden cooling. In addition, these brittle tires, nearly new, had been put under a jolting carriage and were on a section of the road not in very good order, especially as to the rail-joints.

August 5, 1858, the engine of a passenger train on the Great Northern line left the track near Carlton, ran entirely off the road-bed and upset. The cause was the breaking of a tire on one of the leading wheels, which was 42 in. diameter. The break took place at the weld, and a second break followed at a rivet hole, a piece 15 in. long being thrown off from the wheel altogether. The tire was of iron, nearly new, having run 10,120 miles. A bad flaw was found in the weld.

January 15, 1859, the engine of a passenger train on the Lancashire & Yorkshire broke a tire on a leading wheel near Crofton, and was derailed, the only damage done being the breaking of a number of chairs. The tire was of Lowmoor iron, and had run only 2,700 miles; it probably broke at the weld.

December 16, 1859, a wagon in a coal train on the London & Northwestern broke a tire near Wolverton, and a number of cars were thrown from the track and wrecked. One was thrown over on the opposite track, causing a subsequent collision. In this case the Inspector reports that the tire was of poor iron, the weather intensely cold and the breakage not remarkable. The wagon appears to have run nearly 3½ miles with the broken tire before it left the track.

December 18, 1859, a passenger train on the Midland road was derailed at Wichnor Junction by a broken tire under a passenger car, seven cars being thrown off. The tire was of iron, had run about 60,000 miles and had been turned up twice, reducing its thickness on the tread from 1¾ to 1¼ in. In this case the wheel-center was completely destroyed, the rim being broken in several pieces and all the spokes broken off. A piece of the broken tire was picked up two miles back from the point of derailment.

December 22, 1859, near Perry Bar, on the South Staffordshire road, a passenger car was derailed by the breaking of a tire on the leading wheel, and was much damaged. The tire broke in two pieces, the short piece being found 1½ miles back from point of accident, and the long piece near by. Maker of tire and length of service not known; it was 42 in. diameter and had worn down from 1¾ to 1⅛ in. thick on tread. It seems that a rivet hole had been drilled directly through the weld.

February 20, 1860, passenger train on Eastern Counties road was derailed at Tottenham by breaking of a tire of a leading wheel under the engine. Two trainmen and five passengers were killed, and sixteen other persons hurt. The iron tire had worn down to 1¼ in. but was less than 1⅛ in. thick over the weld. The Inspector reports that the break was due to a defective weld, the flaw not being apparent from the outside; he also holds that due precautions had not been taken to secure a sound weld. Concerning the usual practice with tires, he says: "The tires used on railway wheels are *shrunk on* to those wheels, or, in other words, are placed on them in a heated state, in order that they may grasp them tightly during the contraction of the metal in cooling. They are retained in their position on the wheel mainly by the state of tension into which they are thus brought. But they are also secured, in most cases, to the rim of the wheel by bolts. On some railways, the tire is so formed as to be dovetailed, as it were, when in its place, to the rim; and this plan is used both with and without bolts. The latter, when they are employed, give additional security.

"When the tensile condition of a tire, that is in good working order, is suddenly released by its being fractured, in consequence of a defect at the weld or from any other cause, then the tire has a tendency to fly off the wheel; and it requires stronger bolts, or better means than those usually employed, to prevent such a result from occurring."

The Inspector further recommends a method of fastening tires, then adopted by Mr. Beattie, of the London & Southwestern, in which the tire is rolled with an inside flange which buts against the rim of the wheel-center on one side; the securing at the other side being done by bolts tapped through the rim into the tire, or by wedges inserted in slots in the tire and then hammered down. He also speaks with commendation of steel tires, then just introduced for the first time by Mr. Sinclair, of the Eastern Counties line.

June 5, 1860, a passenger train on the Great Northern road was derailed near Southgate by the breaking of a tire on a leading wheel of a carriage. The tire was nearly new, 2 in. thick, and of good iron, secured to the wheel-center by bolts; it broke at the weld, which was very bad. The Inspector in this case again refers to the Beattie method of fastening tires.

December 26, 1860, at Blyton, on the Manchester, Sheffield & Lincolnshire line, a passenger train was derailed and seven persons hurt by a broken tire. The tire was on the trailing wheel of the rear carriage. The wheel was 36 in. diameter, the wrought-iron rim being ⅝ in. thick. The tire was 5 in. face and 1⅜ in. thick on the tread, was fastened to the inner rim by four ¾-in. rivets; it broke at three of the rivet holes. The wheel was of unknown age, and had been turned up eight months before.

December 26, 1860, part of a passenger train on the North Staffordshire road was derailed near Weston by the breaking of a tire. This tire was of iron, $1\frac{3}{16}$ in. thick on tread. It opened at the weld and broke the five rivets by

which it was attached to the center, then left the wheel altogether. The Inspector believed that, with proper attachments to the wheel, the opening at the weld would not have caused any accident. He also notes that the absence of rivet holes would add considerably to strength of tire.

January 4, 1861, passenger train on London, Chatham & Dover was derailed near Sittingbourne by a broken tire under a brake-van. Three cars were derailed and broken. The tire was from the Phœnix Works, 1¼ in. thick on tread and fastened to the wheel-center by four ⅝-in. rivets. It broke at a rivet hole and appears to have been shrunk on too tightly, causing undue tension. The Inspector again takes occasion to commend the Beattie method of fastening (already mentioned); the Gibson annular key fastening; the Mansell wheel with wood center, and the Brotherhood ring fastenings and one or two others. He suggests the use of a tire rolled with a flange, which would but against one side of the rim, and a projecting flange on the inside, which could be hammered down after the tire was shrunk on. In closing he says: "Although there is greater fear in general with regard to a slack tire, a loose tire or a broken tire, the most dangerous tire of all is one which has been shrunk too tightly on the wheel, and whose state of tension renders it ready to fly apart upon any violent blow adminisistered to it by a bad joint or an uneven crossing, in the ordinary course of traffic. This is the sort of tire that yields the clearest ring to the hammer of the examiner, and that inspires him frequently with the greatest degree of confidence; but this is the tire that ought in reality most to be dreaded."

January 4, 1861, passenger train on Shrewsbury & Hereford was derailed near Moreton by broken tire. It was an iron tire, eight months in use, had been turned up once and was 1½ in. thick on tread, fastened to the center by four ¾-in. rivets. It broke at the rivet-holes into four pieces.

January 14, 1861, express train on Great Western road was derailed near Twyford by a broken tire under a car. The wheel was 48 in. diameter, the iron tire 1⅜ in. thick; it had run 22,547 miles. The break was at the weld, where there was an internal flaw. A modification of the Beattie plan was used in fastening the tire on, but there were not clips enough to secure it properly.

January 3, 1861, passenger train on London & Northwestern was derailed near Berkhampstead by broken tire under a carriage belonging to the Caledonian Company. The wheel was 42 in. diameter, the tire nearly new, 1⅞ in. thick and fastened to the center by five ¾-in. rivets. It broke into three pieces, all the breaks being through rivet holes. It had run only 8,900 miles. A bad flaw was found in the body of the tire. The Inspector believes that this flaw might have been detected by careful inspection.

January 10, 1861, mail train on London & Northwestern was derailed near Bangor by broken tire. The tire was on a composite wheel, with cast-iron center, wrought-iron spokes and wooden felloes; these felloes came off when the tire broke. The tire was four years old and 1⅜ in. thick; it broke in six pieces and left the wheel altogether.

January 14, 1861, passenger train on London & Northwestern was derailed near Pinner by broken tire and four passengers hurt. The wheel in this case, as in the last, was a Worsdell wheel, with cast-iron hub, round wrought-iron spokes, wooden rims or felloes and wrought-iron tire. The tire (1⅜ in. thick) broke first, and the whole wheel seems to have came to pieces. The Inspector in both cases condemns this class of wheel as not sufficiently strong.

January 14, 1861, passenger train on Manchester, Sheffield & Lincolnshire was derailed near Lincoln by broken tire under the engine. All the cars were derailed, one passenger killed and two others hurt. The broken tire was on a leading wheel 4 ft. in diameter; it was about 1⅛ in. thick, having run 8,000 miles since the last turning. It broke in five pieces, which were scattered along the line. The Inspector believes that the break was caused by the thinness of the tire and the loss of strength from bolt-holes, and again recommends improved methods of fastening.

February 27, 1861, express train on London & Northwestern was derailed near Tring by the breaking of a tire under a carriage. The tire was a new one, 2 in. thick; it broke at the weld, showing a very large flaw, and opened out 21½ in. The tire was held on by an annular key or ring fitting in a groove turned in the inside of tire. This ring broke also and about 5 ft. of it were missing. The Inspector thinks the annular key was too light and very badly shaped and proportioned.

November 15, 1863, locomotive of a train on the Caledonian Railway was derailed, while going down the Bealtock incline, by the loss of a tire on a leading wheel. The engine upset and several coaches were thrown on top of it, killing a passenger and injuring five others. The tire broke in three pieces, 7 ft. 2 in., 2 ft. and 1 ft. 8 in. long, respectively. The leading wheel was 42 in. diameter and carried about four tons; the tire had run only 2,700 miles and was 2½ in. thick on tread. It was fastened to the wheel-center by five ⅞-in. bolts, and all the breaks were through bolt-holes. A remarkable feature of this accident is that the engine ran no less than 24 miles without the tire. The engineman noticed the rough motion and examined the engine at a station; he found a spring broken and, taking that to be the cause of the rough riding, looked no further.

February 12, 1864, a four-wheeled passenger carriage on the Caledonian road broke a tire when near the Bishopton tunnel. The car ran 2¾ miles before the train was stopped. The tire broke in two pieces, both of them being forced through the floor of the carriage, and one of them killing a passenger. The tire was old and had been worn and turned down from 1½ in. to ⅞ in. It was fastened to the center by four ¾-in. bolts and broke, first at the weld and then at a bolt-hole.

April 14, 1864, locomotive of express train on Great Northern line broke tire of a leading wheel when near Little Bytham and went into the ditch, nearly the whole train following it. The tire broke at the weld and was found in three pieces on the bank. It was of iron 5½ in. wide and 1¾ in. thick on tread, and had run about 30,000 miles. The wheel was 4 ft. diameter and carried about 5½ tons. The tire was fastened to the center by flat keys, on Beattie's plan. The weld was very defective. The Inspector here again urges the necessity of better methods of fastening.

In all the cases above given, the accidents were due to breakage of tires only. In each of the three cases where the wheel broke the breakage followed and was the result of the failure of the tire. The period covered by the accidents given (1853—1864) was that in which iron tires were in universal use, in fact, in one of the later cases, the Inspector mentions the use of steel as something new and commends its introduction.

In a majority of the cases, the failure seems to have resulted from defective welding; in many others from the drilling of bolt-holes through the tire. It is to be remarked, however, that there is no accident due to a loose tire to be found in the reports covered by the present statement.

(*To be continued.*)

Car-Couplers and Freight-Train Brakes.

[From the Ninth Annual Report of the Railroad Commissioners of Iowa.]

Of the importance and absolute necessity of automatic or safety couplers for freight cars, we feel that we cannot recede from the position taken in former reports. We are not, however, sure that the action taken by some of these States in making it the duty of the railroad commissioners of these States to select certain devices for coupling cars, is the shortest and best road to the desired end.

In quite an extended trip through some of these States, where the commissioners have selected several kinds of draw-bars which the railway companies may put upon their cars, a member of this board made it a special work to go into the yards at various places and ask of the yard

masters and men under them how they liked the new draw-bars. The answer invariably was: "We don't like them."

Then they would immediately qualify that answer this way: "If the companies would all agree upon one style of draw-bar and put that on, it would do; but, where there are a dozen kinds, we get confused sometimes when we are in a hurry, and we d—n all these new-fangled affairs, and wish there was nothing but the old link-and-pin."

There is a good deal to this. Michigan has selected some five which are lawful for the railways to put on. New York has chosen six. Massachusetts, five. Now, if other States should select different ones, it must be apparent to the most casual observer that the trouble and danger, instead of being lessened, might be increased.

The conviction is forced home upon us that the only competent parties to choose the coupler for general and universal use are the railroad companies themselves; the only needed legislation upon that point being such as will compel a choice within a reasonable time. It may not be out of place to mention here what seems to us some of the prominent hindrances in the minds of railway managers to a speedy decision of this coupler question. We think these are well-grounded reasons in the minds of all practical railroad men for the almost universal preference for a vertical, plain-hook coupler, after the fashion, somewhat, of the Miller coupler, now so common on passenger cars; but there has been a fear that such couplers would not afford the required slack in order to enable the engine to start the train and help it over sharp grades.

The experiments made last July at Burlington, in the freight-car brake tests, opened the eyes of a great many railroad men. To a great extent, the need of so much slack was shown to be a myth, and it is difficult to tell what those tests, there made, decided most—the true character of the coming safety draw-bar, or the best practical freight-car brake.

This difficulty of slack eliminated, then another very serious one confronts the railway manager.

There are some half-a-dozen or more hook couplers that are so nearly perfect and have so many points in common, no thinking man with the intelligence of the average railroad manager, but fears, if he decides upon any one, he is liable in buying and using it to buy a long, tedious and costly patent-right suit, for no one of the owners of these half-a-dozen hook couplers that are so nearly alike will see his competitor putting his coupler into general use and his own left, but who would, in all probability, at once commence suit for infringement. Could the proprietors of these several hook couplers pool their issues and combine their interest and unite good points of all in one, there is but little doubt that the railroad companies would at once adopt the consolidated draw-bar.

We are not uttering these thoughts at random. These conclusions are the result of quite extensive interviews with a large number of prominent railroad men, as well as with coupler men.

"Whenever these coupler men agree among themselves, where their couplers are so nearly alike and combine, we are ready to adopt some one of these hook couplers as a standard one, but we are not going to buy a lawsuit of any one of these inventors if we know ourselves," is the expression often heard from the lips of railroad managers. Thus we are inclined to the opinion that the safety-coupler men themselves are to-day standing in the way of a speedy adoption of the very thing they, the railroad companies and the public want.

Our attention has been called to the following law, passed by the Legislature of the State of New York (Section 4, Chapter 39, of the laws 1884), which, we think, more nearly meets the wants of the situation than anything in the way of legislation that we have seen:

"After July 1, 1886, no couplers shall be placed upon any new freight car to be built or purchased for use, in whole or in part, upon any steam railroad in this State, unless the same can be coupled and uncoupled automatically without the necessity of having a person guide the link, lift the pin by hand, or go between the cars. The corporation, person or persons operating said railroad, and violating the provisions of this section, shall be liable to a penalty of not exceeding $100 for each offense."

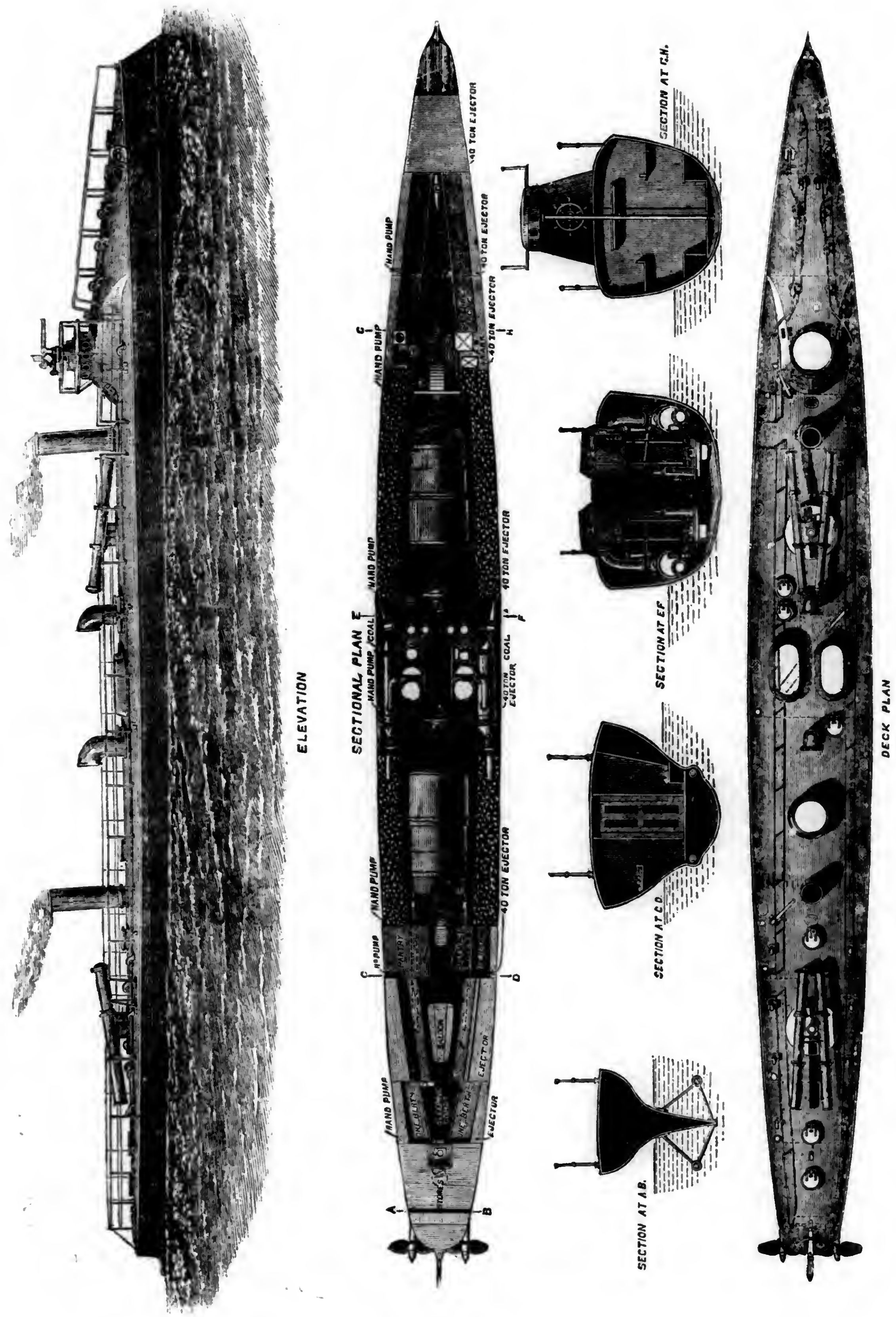
AUTOMATIC OR POWER BRAKES FOR FREIGHT CARS.

Since our last report there has been a long step taken toward a much needed and universally desired improvement in the equipment of freight cars. We refer to the remarkable tests of freight-car brakes inaugurated and carried through most successfully by the Master Car-Builders' Association, at Burlington, this State, last July. That series of tests marks a period of time in the railway history of this nation, second in importance to no other. It was, in fact, a new departure in railroad practice, something entirely novel in this country, but, at the same time, of the highest importance. As an indicator of the times it showed very clearly that railroad companies are keenly alive to public sentiment. They have seen that the public sentiment of this civilization was about to demand something better for brakemen than the common hand-brake, worked by men on top of freight cars.

They saw that public sentiment would eventually crystallize into laws compelling the use of some automatic or power brake, free from the dangers and exposure inseparably connected with those now in use, and it was of the utmost importance for them to know from actual and exhaustive tests which one of the several brakes pushed forward for favorable recognition was the best for all practical purposes. To us it does seem that the responsibility resting upon the Committee of Master Car-Builders who have charge of the tests, and who are to report on the same, is one of the most weighty that falls to the lot of man to discharge. The report of the Committee must, of course, influence more or less every railroad management in the United States in deciding what brake shall be used on its cars. It should also influence future legislation as it may be had in reference to safety appliances to cars. It should be well understood that the large expenditure of time and money to carry on these tests was not designed to be any mere child's play. It meant business through and through, no matter who went down or who went up. The interests at stake reached too far and too wide to allow of any swaying of judgment by any mere individual's interest in any particular brake. The final report of that committee, after the concluding tests next spring, will be looked forward to by every railroad company, and by trainmen as well as by shippers, with intense interest. It is to be sincerely hoped that that report will give no uncertain or double sound. It was chosen, and all this enormous expense has been incurred, to let railway managers know and to inform legislators what is *the* best brake, and what should be adopted. If not for this end, then surely it was indeed "child's play." Any action taken by any of the State Legislatures in reference to an automatic or power brake after the report of that committee, could with reason be based on that report, and no railroad man could complain. Any unnecessary delay of action by the law-making power after such report would be open to censure by trainmen and the public; hence, the heavy responsibility attaching to that forthcoming report.

Yet, this is the only correct way to reach the desired results. Too great commendation cannot be given to the master car-builders who inaugurated, to the committee who had charge of, or the railroad company that furnished the facilities for carrying through these important tests. As said above, a very important mile post is set up in the history of railroad progress in this land.

Before leaving these points, we would respectfully ask of railroad managers, master car-builders, and of inventors and owners of safety and automatic draw-bars: Why not inaugurate a crucial test of automatic couplers, conducted by a competent committee, on something of the same plan and as exhaustive as that of the freight-car brakes? Let this be done and all agree to abide by the report of the committee. We see no other way to reach the desired end unless it be the one suggested on another page in this report, viz.: By several of the vertical hook couplers combining and pooling their interests. Something should be done soon. The people will not allow Legislatures to



TWIN-SCREW TORPEDO BOAT FOR THE ITALIAN GOVERNMENT.

BUILT BY YARROW & CO., POPLAR, ENGLAND.

stand idly by and see the citizens of the State mangled and killed so unnecessarily as they now are by the use of coupling devices that have not been improved in the history of railroad work in this nation.

A Fast Torpedo Boat.

[From the London *Engineer*.]

In a recent impression we gave some particulars of the trial trip of a boat built for the Italian Government by Messrs. Yarrow & Co., which attained the highest speed known, namely, as nearly as possible, 28 miles an hour. On April 14, the sister boat made her trial trip in the Lower Hope, beating all previous performances, and attaining a mean speed of 25.101 knots, or over 28 miles an hour. The quickest run made with the tide was at the rate of 27.272 knots, or 31.44 miles per hour, past the shore. This is a wonderful performance.

In the following table we give the precise results:

	Boiler.	Receiver.	Vacuum.	Revs. per min.	Speed.	Means.	2nd means.
	lbs.	lbs.	in.		Knots per hour.	Knots per hour.	Knots per hour.
1	130	32	28	373	22.641		
2	130	32	28	372.7	27.272	24.956	
3	130	32	28	372	22.784	25.028	24.992
4	130	32	28	377	27.272	25.028	25.028
5	130	32	28	375	23.225	25.248	25.138
6	130	32	28	377	27.272	25.248	25.248
Means.	130	32	28	374½			25.101

The boat is 140 ft. long, and fitted with twin screws driven by compound engines, one pair to each propeller. These engines are of the usual type constructed by Messrs. Yarrow. Each has two cylinders, with cranks at 90 deg. The framing, and, indeed, every portion not of phosphor-bronze or gun-metal is of steel, extraordinary precautions being taken to secure lightness; thus, the connecting-rods have holes drilled through them from end to end. The low-pressure cylinders are fitted with slide-valves. The high-pressure valves are of the piston type, all being worked by the ordinary link motion and eccentrics. The engine-room is not far from the mid length of the boat, and one boiler is placed ahead and the other astern of it. Each boiler is so arranged that it will supply either engine or both at pleasure. The boat has therefore two funnels, one forward and the other aft, and air is supplied to the furnaces by two fans, one fixed on the forward and the other on the aft bulkhead of the engine-room. The fan engines have cylinders 5½ in. diameter and 3½ in. stroke, and make about 1,100 revolutions per minute when at full speed, causing a plenum in the stokeholes of about 6in. water pressure. Double steam steering-gear is fitted for the forward and aft rudder respectively, and safety from foundering is provided to an unusual degree by the subdivision of the hull into numerous compartments, each of which is fitted with a huge ejector, capable of throwing overboard a great body of water. A body of water equal to the whole displacement of the boat can be discharged in less than seven minutes. There is also a centrifugal pump provided, which can draw from any compartment. The circulating pump is not available because it has virtually no existence, a very small pump on the same shaft as the centrifugal being used merely to drain the condensers. These last are of copper, cylindrical, and fitted with pipes through which a tremendous current of water is set up by the passage of the boat through the sea. Thus the space and weight due to a circulating pump is saved and complication avoided. The air and feed-pumps are combined in one casting, let into the engine-room floor quite out of the way, and worked by a crank-pin in a small disc on the forward end of the propeller shaft. This is an admirable arrangement, and works to perfection

The armament of the boat consists of two torpedo tubes in her bows, and a second pair set at a small angle to each—Yarrow's patent—carried aft on a turntable for broadside firing. There are also two quick-firing 3-lb. guns on her deck. The conning tower forward is rifle proof, and beneath it and further forward is fixed the steering engine and a compressing engine, by which air is compressed for starting the torpedoes overboard and for charging their reservoirs. A small dynamo and engine are also provided for working a search-light if necessary. The accommodation provided for the officers and crew is far in advance of anything hitherto found on board a torpedo-boat.

The weather on the morning of Thursday, April 14, was anything rather than that which would be selected for a trial or indeed any trip on the Thames. At 11 A. M., the hour at which the boat was to leave Messrs. Yarrow's yard, Isle of Dogs, the wind was blowing in heavy squalls from the northeast, accompanied by showers of snow and hail. The Italian Government was represented by Count Gandiani and several officers and engineers. In all there were about 33 persons on board. The displacement of the vessel was as nearly as might be 97 tons. A start was made down the river at 11.15 A. M., the engines making about 180 revolutions per minute, and the boat running at some 11½ or 12 knots. During this time the stokehole hatches were open, but the fans were kept running at slow speed to maintain a moderate draught. The fuel used throughout the trip was briquettes, made of the best Welsh anthracite, worked up with a little tar. The briquettes were broken up to convenient sizes before being put in the bunkers. This fuel is not of so high evaporative efficiency as Nixon's navigation coal; but it is more suitable for torpedo-boat work, because it gives out very little dust, while the coal in closed stokeholes half smothers the firemen. Watering only partially mitigates the evil. Besides this the patent fuel does not clinker the tube ends—a matter of vital importance.

During the run down to Gravesend the small quantity of smoke given out was borne down and away from the tops of the funnels by the fierce head wind, and now and then a heavy spray broke on the bows, wetting everything forward. In the engine-room preparations were made for taking indicator diagrams. No attempt was made to drive the boat fast, because high speeds are prohibited by the river authorities on account of the heavy swell set up. The measured mile in the Lower Hope is on the southern bank of ths river, about three miles below Gravesend. Just as the boat passed the town, in the midst of a heavy rain-squall, the stokehole hatches in the deck were shut, and the dull humming roar of the fans showed that the fires were being got up. The smoke no longer rose leisurely from the funnels. It came up now with a rush and violence which showed the powerful agency at work below. A rapid vibrating motion beneath the feet was the first evidence that the engines were away full speed. As the boat gathered way she seemed to settle down to her work, and the vibration almost ceased. The measured mile was soon reached, and then, in the teeth of the northeaster, she tore through the water. The tide and wind were both against her. Had the tide and wind been opposed, there would have been a heavy sea on. As it was, there was quite enough; the water, breaking on her port bow, came on board in sheets, sparkling in the sun, which, the rain-squall having passed, shone out for the moment. As the wind was blowing at least 30 miles an hour, and the boat was going at some 26 miles an hour against it, the result was a moderate hurricane on board. It was next to impossible to stand up against the fury of the blast without holding on. The mile was traversed in less than 2½ minutes, however; but the boat had to continue her course down the river for nearly another mile to avoid some barges which lay in the way, and prevented her from turning. Then the helm was put over, and she came round. There was no slacking of the engines, and astern of her the water leaped from her rudder in a great, upheaved, foaming mass, some 7 ft. or 8 ft. high. Brought round, she once more lay her course. This time the wind was on her starboard quarter, or still more nearly

aft. The boat went literally as fast as the wind, and on deck it was nearly calm. The light smoke from the funnels, no longer beaten down by wind, leaped up high into the air. Looking over the side, it was difficult to imagine that the boat was passing through water at all. The enormous velocity gave the surface of the river the appearance of a sheet of steel for 1 ft. or more outside the boat. Standing right aft, the sight was yet more remarkable. Although two 6-ft. screws were revolving at nearly 400 revolutions per minute almost under foot, not a bubble of air came up to break the surface. There was no wave in her wake; about 70 ft. behind her rose a gentle swelling hill. Her wake was a broad, smooth, brown path, cut right through the rough surface of the river. On each side of this path rose and broke the angry little seas lashed up by the scourging wind. Along the very center of the brown track ran a thin ridge of sparkling foam, some 2 ft. high and some 20 ft. long, caused by the rudder being dragged through the water. There was scarcely any vibration. The noise was not excessive. A rapid whirr due to the engines, and a rhythmical clatter due to the relief-valve on one of the port-engine cylinders not being screwed down hard enough and therefore lifting a little in its seat at each stroke, made the most of it. The most prominent noise, perhaps, was the hum of the fans. Standing forward, the deck seems to slope away downward aft—as indeed it does, for it is to be noted that at these high speeds the fore foot of the boat is always thrown up clean out of the water—and the whole aspect of the boat, the funnels vomiting thin, brown smoke, and occasionally, when a fire-door is opened, a lurid pillar of flame for a moment; the whirr in the engine-room; the dull thunder of the fans, produce an impression on the mind not easily expressed, and due in some measure, no doubt, to the exhilaration caused by the rapid motion through the air. The best way to convey what we mean is to say that the whole craft seems to be alive, and a perfect demon of energy and strength. Many persons hold that a torpedo boat is likely to be more useful in terrifying an enemy than in doing him real harm, and we can safely say that the captain of an ironclad who saw half a dozen of these vessels bearing down on him, and did not wish himself well out of a scrape, has more nerve than most men.

The second mile was run in far less time than that in which what we have written concerning it can be read, and then the boat turned again, and once more the head wind with all its discomforts was encountered. Events repeated themselves, and so at last the sixth trip was completed, and the boat proceeded at a leisurely pace back again to Poplar. Mr. Crohn, representing Messrs. Yarrow on board, and all concerned, might well feel satisfied. We had traveled at a greater speed than had ever before been reached by anything that floats, and there was no hitch or impediment, or trouble of any kind.

The Italian Government may be congratulated on possessing the two fastest and most powerful torpedo-boats in the world. We believe, however, that Messrs. Yarrow are quite confident that, with twin-screw triple expansion-engines, they can attain a speed of 26 knots an hour, and we have no reason to doubt this.

The description of this remarkable boat and its trial trip are taken, as above noted, from the *Engineer*; for the accompanying illustrations, showing the general design and arrangement of the boat, we are indebted to *Engineering*.

The Bussey Bridge Accident.

THE Massachusetts Railroad Commissioners have issued an elaborate report on the accident on the Dedham Branch of the Boston & Providence road on March 14 last, commonly known as the Bussey Bridge accident. This report gives a summary of the evidence taken, a history of the bridge and comments, and gives also views of the wreck and drawings of the bridge. The report does not add much to what has been already published on this accident; the most important part is the summary and the recommendations, which are given in full below, with some of the statements as to the cause of the accident:

THE CAUSE OF THE DISASTER.

The testimony of the passengers, of the employés on the train and of two outside witnesses, shows conclusively that the trouble originated on the north half of the bridge, and the evidence, as a whole, clearly indicates that the original cause of the disaster was the breaking of the hangers at the joint-block at the north end of the Hewins truss In this view the counsel of the corporation and the experts, including the expert employed by the corporation, concur. These hangers were found in the street, and were examined by several people, including one of the Commissioners, on the morning of the accident. They were broken, the upper loops with part of the shank remaining in the joint-block, and the lower loops with the remainder of the shank lying near by.

One hanger was broken through the shank, and about seven-eighths of this break was old. In the other hanger the lower-loop was broken on the side and at its junction with the shank. At the shank there were indications of an old break through about one-eighth of the sectional area. The hangers should have been die-forged. They were loop-welded, and the weldings were imperfect.

The eccentricity, so called, of these hangers was unnecessary. This eccentricity caused the strains to be transverse and unequally distributed. In consequence thereof, the hangers were for their work in the bridge not nearly as strong as the same amount of material would have been had they been properly designed. Portions of them, without making any allowance for the jar of the train, were subjected by each passing engine to strains approaching, if not in excess of, the elastic limit. The margin of strength, if any, was so small as to be inconsistent with safety. Iron will surely break if repeatedly subjected to a load which strains it materially beyond its elastic limit. The hangers were unfit for their work. The wonder is that they held on so long as they did. They had been breaking for some time. On the morning of the accident there was little more than the equivalent of one hanger left.

The theory that the disaster was due to a derailment of the train received no sufficient confirmation. On the contrary, the fact was abundantly established by the evidence that neither the ties on the embankment south of the bridge nor those on the south half of the bridge itself showed any signs of derailment. If a derailment occurred it must have occurred within a few feet of the joint-block at the north end of the Hewins truss.

A theory was also started at the investigation, that the disaster might have been caused by the dropping of a brake-beam between the ties, but the theory was not supported by the necessary evidence. If a brake-beam dropped at all it must have dropped within a few feet of the hangers. * * * *

SUMMARY AND RECOMMENDATIONS.

The conclusions which have been reached by the Board are as follows:

The contract for rebuilding the bridge in 1876 was made without proper examination as to the standing of the contractor.

Those who acted for the corporation in making the contract had not sufficient knowledge of iron-bridge building to enable them to pass intelligently upon the design and specifications.

The design and specifications for the bridge were not such as should have been accepted.

The bridge was constructed practically without superintendence on the part of the corporation, and the corporation neglected to preserve a copy of the specifications, drawings and strain sheets.

The tests of the bridge were not made in the presence of any one acting for the corporation who was qualified to judge of their value.

From the time of the construction of the bridge to the day when it fell, the railroad company had caused it to be examined by one man only, who, year after year, passed

over vital parts of the bridge without realizing that they were of importance. This man had been in the employment of the corporation for a long series of years, his trade was that of a machinist, he had not been educated as a civil engineer, and the management had abundant reason to know that he was not qualified, and had had no opportunity to qualify himself, to do the work assigned to him with reference to this bridge.

The series of tests of the bridge recommended by the Board in 1881 was not made.

In the erection and inspection of bridges the management of a railroad is bound to exercise the utmost care. Had such care been exercised, there is every reason to believe that the disaster would have been prevented. On the thirty-second page of the last the report ofCommission is the following: "The Board renews the expression of its belief that a preventible accideut is a crime."

Notwithstanding the repeated warnings of the Board, the spaces between the ties on this bridge were far too great for safety.

Notwithstanding the recommendation of the Board in 1881, no suitable guard-rails or guard-timbers were placed upon the bridge.

The Westinghouse automatic air-brake, a safety appliance remarkable alike for its simplicity and effectiveness and long ago approved and adopted by all the leading railroads, was not in practical operation on this train, neither was the train furnished with a sufficient number of brakemen to comply with the requirements of the statute.

The disaster and the facts which have been disclosed impose a great responsibility on the Board of Directors. It is their duty, by the most searching inquiry, to ascertain forthwith whether any other work has been done in a like negligent and incompetent manner,whether, in other matters, reasonable and well-approved precautious against accident have been ignored or neglected, and whether false economy has been practised and safety sacrificed. They should not rest until they have taken the most energetic measures, without regard to expense and without regard to persons, to correct the past and to insure better and safer management in the future. So far as relates to bridges, the directors have already caused a thorough expert examination to be begun. Fortunately there are but few bridges on the line.

In mitigation of the sentence of condemnation called for by the foregoing findings and in support of the hope that the history of the Bussey Bridge is exceptional, it must be remembered that from 1869, when the Board of Railroad Commissioners was created, up to the time of this disaster, a period of 18 years, there has been no train accident on the Boston & Providence Railroad which resulted in the loss of a life of, or even in serious injury to, a passenger.

The accident furnishes another proof of the necessity of abolishing the deadly car stove.

As bridges embody many possibilities of danger, it is proper that special means should be taken to secure careful, competent and faithful construction and a thorough and scientific examination of them by the railroads at regular intervals, followed by a thorough State inspection. The importance of such action is emphasized by the fact that the weight of engines and of the rolling-stock of railroads and of the loads carried has been increasing for many years. The weight of engines and rolling-stock has doubled within 20 years. Moreover, the speed of the heavy passenger express and through freight trains has also largely increased.

The examination made by the Board of Commissioners can at best be but cursory. There are over 1,000 bridges in the State, and no member of the Board, no matter what his scientific education may be, can, in addition to his other duties as Commissioner, make anything but a brief, partial and unsatisfactory examination of them. A proper inspection in behalf of the State would require, practically, the whole time of a bridge expert.

The Board recommend the passage of an act requiring every railroad, at least once in two years, to have a thorough examination of all bridges on its lines made by a competent and experienced civil engineer, who shall report in writing to the corporation and to the Board of Railroad Commissioners the results of his examination, his conclusions and recommendations. The reports should embrace such information in relation to the history and construction of each bridge, including detail drawings and strain sheets, as may be called for by the Board of Railroad Commissioners. and said Board should be authorized to employ a competent expert to examine such reports and make such further examination of the bridge structures as may be deemed necessary or expedient.

New York Harbor Improvements.

(From the New York *Times*.)

THE river and harbor improvement work in the vicinity of the city is at present going on somewhat slowly, owing to the fact that the last session of Congress did not result in adding to the appropriation for that purpose. The work, which is very diverse, is being carried on upon the unexpended funds remaining of the previous appropriation. It covers a wide area, however, and is of very general interest.

In the East River, ever since Flood Rock went first up into the air and then down into the water in October, 1885, the task has been simply one of dredging. It is somewhat different from mud dredging, however. The material to be removed consists wholly of broken rock, and the dredge is a huge grapple, shaped like a clam shell with iron fingers or teeth. It is lowered in an open condition to the bottom, and, once there, the span is equal to a stone of 15 ft. in length. Recently a 38-ton rock came to the surface in one haul—the largest result which any steam grab bag of the kind has ever produced. Only one dredger is now at work, the second contract being in progress. The first was for the removal of 30,000 cubic yards and was completed in last July. The second covered 50,000 yards, of which 30,000 have now been taken away. The dredger has double crews and is at work night and day.

The results thus far consist in a 350-ft. channel across the reef, with a depth across the entire width of 18 ft. No wrecks have been known in Hell Gate since the explosion, where before they were of daily and, in fact, tidal occurrence. The estimated traffic passing through there is now $4,000,000 per day. All the ships from Newtown Creek and the refineries and other industrial enterprises in that vicinity go and come by that route, and 4,000-ton steamers, 350 ft. in length, are frequent passengers, where they were formerly unknown.

The work is by no means completed, however. To create a depth of 30 ft. across the whole reef will require the removal of 350,000 cubic yards. Flood Rock proper is still out of water, though the rock is broken up to a depth of 30 ft. Its removal is simply a question of dredging. The Nigger-Head Reef has a depth of 18 ft. at low tide. The Hen-and-Chickens also has a depth of 18 ft. and these two were the main obstructions. The Gridiron is almost bare at low tide, but the plans contemplate a uniform depth of 26 ft. at low tide over the entire area.

Over Frying-Pan Rock, a reef about 200 by 100 ft. in size 1,000 ft. north of Flood Rock, there is now a depth of about 18 ft., which is to be increased to the regulation limit. The process consists in excavating 6-in. holes with a steam drill, working in a dome which rests on the bottom. The hole is bored to a depth of 16 ft. and then blasted. The same plan of working from the surface has been pursued with Pot Rock, between Negro Point and Astoria. This is a reef about the same size as the Frying Pan, and originally had a depth of only 8 ft., which has, however, been increased to 24 ft. Negro Point is at the south end of Ward's Island. This reef is 300 ft. long and is about two acres in area. It will require to be mined and be subjected to the gentle suasion of 50,000 pounds of powder to destroy its present cohesiveness. When these various improvements are completed there will be a clean channel, 1,290 ft. wide and 26 ft. in depth, through that part of the East River which, in the whole previous history of American navigation, has been known only to be avoided. It is approximately estimated that $1,000,000 will cover the entire expense, and two years suffice for the

necessary time. As Congress will not reach the appropriation bill, however, until near the close of the next session, there is no immediate prospect that the work will be soon completed.

The Harlem River project, by which the North and East Rivers will be united through a channel 15 ft. deep, is in a promising condition. The Commissioners appointed to assess the damages and benefits have filed their report, and it has been accepted in Washington. The appropriation of $400,000 made by the Government some years ago for this work now becomes available. It was made with the proviso that the work should not begin until the Government had secured, without expense, the right of way, and it was to attain this that the Commissioners were appointed. The work will begin in a few weeks. There is a large amount of excavation to be done, as the proposed channel runs across two hills, each 50 ft. in height, and other upland of inferior altitude.

The improvements in the Raritan Bay Channel, through to South Amboy, are well advanced, but require further work. The Raritan River is being dredged on the plans contemplating a depth of 12 ft. as far as New Brunswick. There is only $26,000, however, with which to do the necessary dredging, and, where the river is wide, the diking to protect and preserve the dredged channel. The sum of $20,000 will be needed to complete the work. In Shrewsbury River it is proposed to make a 6-ft. channel to Red Bank and Branchport, the harbor of Long Branch. This requires $100,000, of which $10,000 are at hand. The Passaic, which it is proposed to deepen to 12 ft. up to Newark, will require $100,000, of which $26,000 has been appropriated. All of the work mentioned is under the general supervision of Walter McFarland, Lieutenant Colonel of Engineers, the New Jersey improvements being in charge of his assistant, Lieut. G. M. Derby.

The most important work now in progress is the deepening of the main bay channel. Proposals have been asked for the dredging of 1,000,000 cubic yards in the vicinity of Flynn's Knoll. The knoll is a shoal two miles long, west and north of the South Spit. Its present minimum depth at low tide is 23 ft. 3 in. It is proposed to make a channel 30 ft. deep and 1,000 ft. wide. A contract has already been let for deepening and widening Gedney's Channel to the degrees named, and this work is now in progress. Gedney's and what is known as the main channel are the means of approach for all the large sea-going vessels. Work is also in progress for the deepening of Buttermilk Channel from 22 ft. in places to 26 ft. uniformly. Gowanus Creek is to be dredged to a depth of 18 ft. up to the Hamilton Avenue bridge, and Newtown Creek to a depth of 18 ft. as far as the drawbridge.

Surveys are also in progress to ascertain the condition of the bar. This, contrary to a general belief, is not shallowed by the detritus from the rivers and bay, but by the action of the ocean currents. The work employs a tugboat and a rowboat and is carried on in very much the same fashion as land surveying. Two tripods between 40 and 50 ft. in height, are planted and serve as transit stations, a transit and its operator being placed on each. Each sounding point is thus located and the depth measured. The work has not advanced far enough to give definite results as to the general changes in the bar since the last survey. Favorable weather is a prime necessity in the work, and available days have not been numerous for some time. If the weather continues pleasant, and the water sufficiently calm, results can be announced in about two weeks more.

The Gogebic Iron Ore Mines.

(From the *Engineering and Mining Journal.*)

THE Gogebic Range iron ore mines are certainly the most important mineral development of recent times. In the three years since the first mine was discovered, the opening of mines has proceeded at a marvelous rate; but the extent of the ore-bodies opened is scarcely less remarkable than the rate at which the ore has been extracted.

The Gogebic Range extends in a northeasterly and southwesterly direction for a distance of perhaps 30 miles, about half of which is in the State of Michigan, and the other half in Wisconsin. The ore is found, as has been many times described in these pages, in lenses of two, more or less parallel, so-called veins, which are in general from 300 to 400 ft. apart and dip to the northwest, conformably with the country rock, and at an angle which varies from 50° to 70°. These ore bearing zones are called the South and North veins, a designation which answers very well, though, in connection with the illustrations that have been published, it may give the erroneous impression that the ore is continuous in each vein over the entire length of the range. As a matter of fact, the ore occurs as lenses in these "veins" or ore zones, and these lenses, while dipping to the northwest with the general dip of the vein and country-rock, have also a dip to the east in the vein. If this page were the vein dipping north at an angle of say 65°, the top and bottom of the page representing horizontal lines, then an ore body or lens commencing at the upper left hand corner, would cross the page from left to right (southwest to northeast), at an angle of 30° to 40° with the horizontal line. The degree of this dip, thus generally stated, has not been accurately determined, though it is recognized in every mine yet opened, and probably varies between the figures given.

This northeasterly flat dip of the ore lenses in a vein which has a general dip to the northwest, is a point of considerable importance in some cases, for it may quickly carry large ore-bodies out of any given property where they outcrop near its eastern boundary.

The ore-bodies in the north vein appear to be much less regular and well defined than those in the south vein, Indeed, at the Colby Mine, where both veins are worked extensively, the ore-body in the north vein appeared at a very moderate depth to be cut off, but upon investigation was found to be in the foot-wall in an irregular mass, with pieces of the foot-wall rock jutting out into the ore in the most capricious manner; and though probably nearly 100,000 tons of ore have been extracted from this vein, it is yet uncertain whether, the ore-bodies in the north and south veins may not meet in depth. The intervening rock, which was more than 300 ft. in thickness on the surface, is scarcely more than half this thickness at a depth of 150 ft.

And yet the extreme irregularity in the north ore-body of the Colby mine and in its foot-wall, in connection with the remarkable parallelism of the finds of ore on the surface in the two veins, appears to indicate that the rock between the ore bodies is not merely a "horse," which will give out in depth and bring the ore-bodies together, but that these lenses occur in two separate zones, though in places, as in the Colby Mine, the north ore-body, which has there an abnormal thickness, may have replaced a portion of the quartzite and jaspery slates which separate the two veins or ore zones.

The very origin of these deposits precludes the idea that the north and south ore-bodies can be considered as parts of the same vein, with simply a "horse" of rock between.

As already stated, the ore is collected in lenses in the ore-bearing zone, and these lenses are of all sizes, from a few feet in length and thickness to masses which have, in a few cases, been proved continuous in horizontal length for nearly or quite 1,000 ft., and that swell out in places to a proven thickness of from 150 to even 200 ft. of 60 to 63 per cent. ore. These lenses occur at intervals in the ore zone; sometimes they lie in echelon, one overlapping the other, and separated by but a few feet (usually at the present depth) of a soft talcose rock known locally as "soap rock," and sometimes they are separated by a considerable thickness or length of hard jaspery slates.

The iron ores of the Gogebic Range are generally soft hematites, or sesquioxides of iron; but occasionally hard ore is found, and in some cases even the radiated or needle ore.

These "veins" lie conformably between a quartzite, or metamorphosed sandstone, foot-wall, and a siliceous jaspery slate top or hanging wall. The ores, as well as their surrounding rocks, are undoubtedly of sedimentary origin, and were probably deposited originally as carbonate

of iron—somewhat similar to the carbonate deposits at Burden, on the Hudson River—and they have since been altered or metamorphosed until in this district they are soft hematites, and in the Marquette Region are hard magnetic or specular oxides.

Though their very origin renders these ore-deposits more uniform and permanent than many others, yet it must not be expected that workable ore will be found at all points in the "veins," or that they will be found of equal quality at all depths. In some cases, to which we shall hereafter refer, large bodies of clean shipping ore have been found to commence at the very grass roots, while more frequently the ore near the surface is more or less mixed with bands of jaspery slates and other rock, and is too silicious to be marketable. In these cases the ore has very frequently improved in depth, becoming less mixed with rock. No doubt this improvement has been so general as to justify, in a measure, the general expectation that a find of "mixed ore" may lead to a body of clean ore in depth; but the rule is far from being universally true, and the expectation that all occurrences of mixed ore are only the caps or tops of clean ore-deposits, is not only not to be relied on, but it is not so generally the case as those whose fortune depends on the acceptance of the theory would, very naturally, have one believe.

In short, the value of each particular property depends on its own developments, and those on adjoining ore-bodies which will enter it; on the position of its ore-bodies with respect to its boundary lines; on the quality of its ores, and on the cost of mining and putting them in market, including the royalties or ground rents to be paid. Most of these are questions for expert determination.

Every important investment in this, as in every other, mining district should be guided by expert advice; but we shall, in referring more particularly to the several mines along the range, give some pointers, which may serve as general guides in estimating values.

That these are now in many cases grossly exaggerated, every one who investigates their foundation can easily see; but the fact that the Gogebic Range possesses a very considerable number of magnificent mines, and that vast fortunes have been made in booming Gogebic stocks, prepares, or should prepare, every one to expect the floating of worthless property, and the vast exaggeration of the values of some of the good mines.

The Iron Ore Belt of Minnesota.

(From *Science*.)

The annual reports of state surveys are, for the most part, dull reading, especially for non-residents; since they are necessarily of a detailed and fragmentary character, showing the progress of investigation in many different directions, with very little completed work. The reports of the geological survey of Minnesota for 1884 and 1885, however, embody material of more than local interest, and it is desired to call attention here to those portions, without attempting to notice the entire contents of the volumes.

The notes on the section from Duluth north to the iron mines about Vermilion Lake give Professor Winchell's latest views concerning the stratigraphy of the crystalline rocks of Northeastern Minnesota, between Lake Superior and the international boundary. The height of land between Lakes Superior and Vermilion is marked by two distinct ranges—the high and broad Mesabi Range, composed of eruptive gabbro and red metamorphic granite; and, north of this, the lower and narrower Giant's Range, consisting of gray and red syenites, which have been referred to the Laurentian, and mark an important anticlinal axis. North of this axis, and dipping north at high angles, is a broad belt of the green and red jaspery and magnesian schists and conglomerates referred to the Huronian. South of the axis, the Huronian series appears to be concealed by a fault; but we have above it, dipping to the south in conformable succession, the Animikie slates and quartzites, the gabbro and granite of the Mesabi Range, and the greenish trap of the cupriferous series, extending from the Mesabi Range to Lake Superior.

The gabbro, Animikie and Huronian series are each characterized by important deposits of iron ore; and this district is, with almost phenomenal rapidity, assuming a position of the first importance as regards the products of its mines. The iron of the gabbro belt is, as usually with rocks of that class, titanic. It furnishes the iron-sand of the Lake Superior beach, and, so far as known, has no parallel in Michigan and Wisconsin. The iron ore of the Animikie slates is hard hematite and magnetite, and probably parallel to the Commonwealth Mines of Wisconsin, but without any known equivalent in Michigan, while the Huronian deposits, occurring chiefly about the south end of Lake Vermilion, consist almost wholly of hematite, and seem to agree closely in character and position with the Marquette and Menominee deposits of Michigan and Wisconsin.

The Vermilion Lake Mines are being rapidly exploited, and the discovery of these ore bodies is regarded as marking an epoch in the economic history of Minnesota and the Northwest.

The salt wells of Northwestern Minnesota and the adjacent portions of Dakota and Manitoba are believed to give promise of important developments; and various facts are cited tending to show that, although the occurrence of carboniferous strata in this region has not been heretofore definitely known, these brines, like those of Michigan, really have their source in that formation.

Sir William Armstrong on Swift Cruisers.

On Saturday afternoon (April 9), in the presence of more than 100,000 spectators, the monster armor-clad war vessel *Victoria*, the heaviest ever successfully floated, was launched from the Elswick shipyard of Sir W. G. Armstrong, Mitchell & Co. (limited). The following are the dimensions of the vessel: Length 340 ft., breadth 70 ft. 6 in., mean draft 26 ft. 9 in., displacement in tons 10,500, horse-power 12,000. She is protected by armor 18 in. thick, and will be armed with two 110-ton guns, twelve 6-in. guns, and about 90 smaller guns. The *Victoria* also possesses a powerful torpedo attack. She glided into the water gracefully, after having been christened by Mrs. Forwood, wife of the Secretary to the Admiralty, Mr. Forwood, M.P. Lord Charles Beresford was present, and also Mr. W. K. White, Chief Constructor of the Navy.

Sir William Armstrong first proposed the toast of "The Queen," and it was heartily responded to. Sir William next proposed the toast of the day, "Success to the *Victoria*." He said that she was not only the first armor-clad the company had ever built, but was the heaviest ship that had ever been successfully launched in this country. The Admiralty seemed disposed to slacken their expenditure upon these gigantic vessels and to expend their operations in the building of swift cruisers, and he had always said that what England wanted above all things was a numerous fleet (hear, hear) of swift cruisers, not extemporized out of passenger boats or merchant ships, but built and especially adapted for the purpose for which they were intended—for the protection of our widespread commerce, and for aiding in the defense of our colonies. Now, for the purpose of comparison between the ships of the present day and the ships of the past, he could take no more fitting example than the *Victory* of the old time and the *Victoria* of to-day. Nelson's ship, the *Victory*, was one of the largest of her time, and yet her displacement, with everything on board, was only 3,500 tons. That of the *Victoria* of to-day was 10,500 tons. The *Victory*, in accordance with the usage of her time, was built of oak. The *Victoria*, in accordance with the usage of our time, was built of iron. The *Victory*, of course, depended entirely upon the wind, while the *Victoria* was dependent upon steam. The speed of the *Victory* under the most propitious conditions was barely 13 knots an hour; while the *Victoria*, propelled by her engines of 12,000 horse power would probably reach a speed of 17 knots per hour. The heaviest gun on board the *Victory* was under three tons, while the largest gun on board this vessel would be 110 tons. The largest and heaviest shot used on board the *Victory* at Trafalgar was 68 pounds; the largest and heaviest on board the *Victoria* would be 1,800 pounds.

The weight of metal delivered from the *Victory's* broadside was only 1,150 pounds, while that delivered from the broadside of the *Victoria* would be 4,760 pounds. In point of range, artillery penetration, shell power and so forth, the difference was so enormous that a comparison could not be drawn. The armament of the *Victoria* would be two guns of 110 tons firing ahead and on either side, one gun of 30 tons firing astern and on either side, 12 guns of 5 tons each in an armored battery, 12 6-pound quick-firing guns, and 9 3-pound quick-firing guns, besides machine guns for smaller ammunition; and in addition to her artillery she had a powerful ram and eight torpedo discharges, four above water and four below. In the days of the *Victory* a little ram was the practice and torpedoes were wholly unknown. Therefore, they could have no comparison in that respect. Another point on which the *Victoria* compared most favorably with the *Victory* was in the smallness of the number of men the *Victoria* would need to handle her. The complement of the *Victory* was 850 officers and men. The *Victoria* was three times as big, and the number of men required was only 550, and, of that number, 110 were engineers and stokers. It was then impossible to work the armament of the big guns now in use. Hydraulic power was now used. Sir William proceeded to argue that the large amount of money spent upon the navy was not lost, but was beneficial to the nation at large in many ways, and he resumed his seat amid loud cheers. *London Daily News.*

Fifty Years of Yacht Building.

[Abstract of paper read before the British Institution of Naval Architects, by Mr. Dixon Kemp.]

THIS paper reviewed the changes in this branch of shipbuilding during the past half century, tracing the effect of the departure from old theories.

The few yachts above 20 tons in existence in England 50 years ago were modeled after brigs, schooners or cutters of the Navy. The brigs especially were about the size of those of the Navy, but were considered superior in sailing qualities. One of the best known was the *Waterwitch*, built by Joseph White, of Cowes, in 1832. This brig had a great reputation for speed and weatherliness, and beat H. M. S. *Pantelon* about 4 miles in a 6 hours' sail to windward. The *Waterwitch* was bought by the Admiralty, and subsequently Mr. White built other brigs for the Navy, notably the *Daring*. This vessel and the *Waterwitch* performed the best to windward in a strong wind and head sea in the experimental sailing of 1844.

The cutter rig was so superior in point of weatherliness, the author claimed, that its adoption for almost all yachts intended for racing was a matter of natural selection. Between 1815 and 1837 there was seldom any time allowed for difference of size, and the result was that, with any kind of breeze, the largest vessel came in first and won. As there was no tax of any kind on any of the dimensions, there was no inducement on that score to alter the proportions of length, breadth and depth from the prevailing Navy type. These proportions were from 3 to 3½ beams to length of water-line, and the greatest transverse section was placed ahead of the middle of the length, by a distance varying from one-tenth to one-fiftieth of the length. The center of buoyancy was generally situated at about the center of length, and it appears to have been an aim of the designers to keep the displacement of the fore-body and after-body equal. The upper horizontal water-lines of the bow were short and full, and the load water-line aft was generally full, but the buttock or vertical lines were long and flat. The *Fair Rosamond* schooner of this cod's-head type was designed by Mr. Fincham, and built in 1846 by Mr. Campe, of Gosport, for the late Duke of Marlborough. Mr. Fincham stated that the center of buoyancy of the *Fair Rosamond* was .004, in terms of the length, abaft the center of length, and that she would have performed better in a head sea had her center of buoyancy been farther forward. In 1847, he designed the *Novice* schooner for the Earl of Desart, and placed her center of buoyancy .01—9 in.—ahead of the center of length. There is no doubt that Mr. Fincham was much mistaken in attributing so much subtle influence to slight variations in fore-and-aft positions of the center of buoyancy. About this time the theory of the late Mr. John Scott Russell—that the bow should be longer than the stern—began to be accepted as nearer the truth than the old theory of the cod's head; and, in the year 1847, whilst Mr. Fincham was designing the *Novice*, a very remarkable vessel was built on the Thames as an exponent of Mr. Scott Russell's theory. This was the *Mosquito* cutter of 59 ft. water-line and 15 ft. 4 in. beam, built by Mr. Mare, of Blackwall, and launched in 1848. The *Mosquito* was like one of the cutters of the period turned end for end; her bow was long, and showed considerable hollow, and her after body was short, showing great fullness both in the horizontal and buttock lines. Her midship section was placed 4 ft. 6 in. abaft the center of length of water-line, and her middle of buoyancy was 2 ft. abaft it. According to the old practice, the *Mosquito* should have had no good qualities at all, especially in strong winds; but the fact is, she excelled in all the good qualities claimed for the bluff-bowed craft; she was faster than any other yacht of her length, on any point of sailing, and, in a strong wind to windward, was a marvel compared with other yachts. However, so strong was the prejudice against the "long, lean bow," and so alarming the predictions—that some day the *Mosquito* would take a dive and never come up again—that no one could be found to try the experiment on a more extensive scale. It thus seemed likely that the old type would be continued in spite of the *Mosquito* having, in a superior degree, all the good qualities it was contended a yacht should have.

So far as can be learned, the first American yacht race took place just 50 years ago, and it does not appear that any yachts existed in the United States before 1835, and those built subsequently, up to the year 1844, were small schooners. In the year named, however, a remarkable vessel was built in Hoboken, named *Maria*, on the lines of the flat-bottomed coasters. She was 100 ft. on the water-line, with an extreme beam of 26 ft. 8 in., and draught aft of 5 ft. 3 in. She was fitted with a center-board which dropped 16 ft. below the keel, and also had a small one aft to prevent her griping. She had a long hollow bow, and was sloop rigged, with jib and mainsail only. The foot of her mainsail was 92 ft. long, and the foot of her foresail or jib, 70 ft. This vessel may be said to have been the original of the American center-board yacht; but, although she showed extraordinary speed and weatherliness, there appears to have been a conviction that more depth of body and less beam would be better for good sea-going qualities. At any rate George Steers—the son of a Devonshire shipwright who had settled in New York—produced the keel yacht *America*, which was destined to have such an important influence on British yacht building and sail-making. In the *America* the principles so successfully carried out in the *Mosquito* were embodied with equal success; she had a long and somewhat hollow bow, a short run, and the center of buoyancy was considerably aft of the middle of length, as will be gathered from the accompanying table:

	Mosquito. Feet.	*America* Feet.
Length on water line	59.2	87.3
Breadth, extreme	15.3	22.2
Draught of water, extreme	11	11.5
Proportion of beam to length	0.257	0.254
Midship section aft center of length in terms of length of L. W. L	0.076	0.071
Center of buoyancy ditto	0.032	0.041

The *America* visited us in 1851, and achieved a remarkable success at Cowes over our schooners. This success was, no doubt, mainly due to the qualities of her hull, but the unusual flatness of her sails contributed greatly to her fine weatherly qualities. The immediate effect of the *America's* success was rather startling; almost every yacht in existence at that time was lengthened by the bow, her masts raked, and sails laced to the booms; and the principles which had been so strikingly exemplified in the *Mosquito* three years before were now adopted as a new discovery of infallible merit. This marked the commencement of a new era in yacht designing, and the subsequent development of yachts into the now fashionable type has shown no considerable departure from the principles observed in the design of the *Mosquito*.

As soon, however, as yacht racing became a general summer pastime, a rating for size became a necessity, and the size test adopted was simply the registered tonnage of the day, or what we now know as builders' measurement, which took no account of depth, but assumed that it always equaled half the breadth. Frequent competition, and the teachings of investigators of naval science, impressed yacht builders very forcibly with the fact that the element of size which gives speed is length; and that if two yachts were of equal tons, but one should happen to be longer than the other, then the longer boat would be certain to prove the faster, all other things being equal, such as sail spread, stiffness and fairness of lines, etc. Or if two vessels were of equal length and one measured fewer tons than the other, then her rating would be smaller, and she would receive a compensating time allowance. Although lead keels had some years previously—about 1846—been introduced as a means of increasing stiffness, after shifting ballast to windward during match sailing had been abolished; but up to 1870 no yacht was to be found with more than about a tenth of her ballast on the keel, and the majority had none at all. A better knowledge of the good effect of concentrating the ballast in the middle third of the length of the vessel rapidly led to a larger quantity of lead being placed outside, until at last the whole ballast was placed outside on the keel. This lowering of the ballast, and consequently of the center of gravity enabled the designer to dispense with a considerable quantity of breadth and add to the length for any given tonnage, until, in some of the smaller yachts, the length has been equal to 6½ beams, and in the larger, 5¾ beams The power to carry an effective quantity of canvas in narrow yachts has not, however, been entirely due to placing the ballast outside; for any given nominal tons the displacement has been largely added to this. These large additions to the displacement, whilst the power for getting through a head sea may have been increased, have had a prejudicial effect on the attainment of high speeds, mainly on account of the enormous wave-making it induced. Thus, so recently as 1880, the *Arrow* has been driven in strong winds as fast and sometimes faster than the *Formosa* or *Samœna*, and with very considerably less wave disturbance. The lead keel of one of these long, narrow yachts, it should be explained, is in breadth about one-third of the main breadth of the vessel, and in weight is equal to about 0.5 of the total weight of vessel in a yacht like the *Galatea*, to 0.7 of the total weight in a 3-tonner. The Americans did not much alter this center-board type of yacht and keel yacht during the period between 1845 and 1885. Accordingly, when, in 1885, the owner of the British cutter *Genesta* challenged for the cup won by the *America* at Cowes, in 1851, the Americans set to work to produce a compromise yacht, but distinctly more American in type than British. This yacht, in section, was of the broad V character—very like the *America* of 1851—with almost twice the draught of water that the ordinary shallow center-board yacht had. Beyond this she had nearly the whole of her ballast outside, in the form of a lead keel, supplemented by a center-board of considerable area. This yacht was named *Puritan*, and, so far as can be judged, she defeated the *Genesta* on her merits. The same fate befel the *Galatea* last year, the Americans having built another yacht of this new type to meet her.

Triple-Expansion Engines.

(From *Engineering*.)

AN interesting table has been compiled to show the difference in the fuel consumption of a number of steamships, part of which had compound and part triple-expansion engines. The results of the working of 11 compound and 9 triple-expansion engines are given in the table which was attached to a paper recently read at the Northeast Coast Institution of Engineers and Shipbuilders, by Mr. J. P. Hall. The paper was an attempt to discover the relative value of the two kinds of engines "from a shipowners point of view," and after dealing with the questions of space, of wear and tear, and of the life of the different kinds of boilers, the writer dealt with the very important question of fuel consumption. The vessels, whose performances are given, are of the cargo-carrying type, many of them built by the company (Palmer's Shipbuilding & Iron Company, Limited) Mr. Hall is connected with, and where this is not the case he considered that the facts were equally to be relied on. Care was taken to select voyages where the weather was "reasonably fine, and as nearly as possible uniform." The tables are thus arrived at: The "consumption is taken at a speed of 10 knots, either increased or reduced, on the assumption that the power or coal varies as the cube of the speed," and the consumption tables are thus brought to the speed of 10 knots with 1,000 tons weight, and 1,000 knots steamed, for simplicity in comparison. Thus tested, the 11 steamers fitted with compound engines had a consumption of 19.748 tons on the displacement performance, whilst the 9 triple-expansion engined steamers had a consumption of 14.859 tons on the displacement performance. On the deadweight performances the compounds had a mean consumption of 30.481 tons, and the triple-expansion engines one of 22.744 tons. Thus the saving on the average of the vessels is 24.75 per cent. on displacement performances, and 25.38 per cent. on the deadweight performances. Mr. Hall gives in his table a number of instances in detail out of which these averages arise, one of which, being a comparison between two vessels owned by the same firm, and under the same superintending engineer, of similar size and speed, as well as on the same voyage (from Liverpool to Bombay and back), may be thus given:

Consumption of Coal per 1,000 Tons carried per 1,000 Knots.

Displacement Performance.		Deadweight Performance.	
Result.	Saving in favor of Triple.	Result.	Saving in favor of Triple.
tons.	per cent.	tons.	per cent.
18.892		29.555	
	22.72		21.65
14.598		23.156	

Several other instances are given, but as they are like that above included in the general summary and result it is needless to quote more.

The Gandak Bridge.

(From the *Indian Engineer*.)

THE first proposal to bridge the Gandak River at its present site was brought forward in March, 1883, or just four years ago. The idea was that the several systems of meter-gauge lines north of the Ganges should be connected with each other. These systems were mainly three: the Bengal & Northwestern Railway, the Tirhoot State Railway, and the Northern Bengal and connected State Railways. The obstacles to through communication between these three systems of lines were mainly the two great rivers, the Gandak and the Kosi, which drain Nipal, and, after emerging through narrow gorges in the lower ranges of the Himalayas, rush with great and destructive velocity across the clay plains of Behar and Bengal to join the Ganges, the Gandak near Patna, and the Kosi between Bhagulpur and Sahibganj. The very early importance of the town of Patna, which was known to ancient Greek and Chinese travelers, must, in all probability, be largely ascribed to its situation at the junction of two great natural river highways. Mighty streams which were formerly aids have now, however, become obstacles to traffic, as is evidenced by the number of big bridges which are being rapidly erected all over India, not the least important of which is that over the Gandak.

The general tendency of the bulk of the produce of the Northwest Provinces, Behar and Bengal, is to seek

European markets through the port of Calcutta. There is, however, a considerable interchange of produce between the different districts, the conditions of which vary considerably owing to such disturbing causes as soil, climate or labor supply. Thus, while the produce of the Northwest Provinces or of Tirhoot, which seeks the port of Calcutta, can advantageously be brought on to the East Indian Railway at Patna and Mokameh, respectively, by the Bengal & Northwestern and the Tirhoot railways, it was considered necessary, in the interests of the local inter-district trade in sugar, tobacco, rice, etc., as well as for the economical working of the railways themselves, that they should be connected by a bridge across the River Gandak.

The Secretary of State's sanction was, therefore, obtained to its erection, and the first commencement of work was made in October, 1884. The bridge has now been completed, and was opened March 30, 1887. It has, therefore, occupied less than 2½ years in erection.

Under the general title of Gandak Bridge are included 3⅓ miles of railway, connecting the Sonpur terminus of the Bengal & Northwestern Railway with the Hajipur terminus of a branch of the Tirhoot State Railway. These 3⅓ miles of line contain five minor bridges and culverts, as well as the main bridge.

The river, where spanned by the bridge, is about 2,000 ft. wide, with a bed of exceptionally troublesome running quicksand, which is always liable to alteration with every few inches change of level of the river. Floods are known to rise to a height of 22 ft. At one point of the bed of the river, solid ground is only reached at a depth of 80 ft. beneath the surface of the quicksand.

The bridge consists of eight spans of 250 ft. each, resting on piers, which, by means of the usual Indian system of wells, have been sunk into the quicksand and solid clay to depths varying from 40 to 90 ft. The abutments have been founded in the solid ground at a depth of about 30 ft. below the surface of the bank. The girders contain altogether about 2,500 tons of steel and iron, the steel in one girder being 190½ tons.

The length of the bridge, inclusive of the abutment, is 2,100 ft. The 3⅓ miles of railway, which include the bridge, will cost about $714,000, out of which about $500,000 represents the cost of the bridge itself.

Great difficulty was experienced in traversing the valuable grove of timber usually occupied by the Sonpur Fair, without taking up too much ground; this difficulty was got over by the construction, within the limits of the Fair ground, of an arched viaduct, nearly half a mile long, the arches of which will be used as shops during the Fair. In return for the use of these arches, the land upon which the viaduct stands has been given free by the owners.

Since the commencement of the work it has been carried out under the orders of Mr. Horace Bell, Superintending Engineer in the Public Works Department, the Manager and Engineer-in-Chief of the Tirhoot State Railway. Mr. R. A. Way, Executive Engineer, has been in immediate charge of the work since soon after its commencement, when it was, for a short time, in charge of Captain Kunhardt.

Hydraulic Cement.

IT must be admitted that the general distribution of chemical knowledge in all branches of the engineering profession is creating a vast revolution in our ideas and playing sad havoc with many time-honored institutions. In few cases is this more clearly shown than in the incessant—we had almost written wearisome—discussions and quibblings now going on in many of our scientific contemporaries anent the relative merits of various artificial hydraulic cements employed for the purposes of construction. And yet the question as to what should be the composition and qualities of a good cement really seems to us to lie in a nutshell, when we remember that, roughly speaking, it is actually prepared by calcining, until near the vitrification point, the purest obtainable calcium carbonate with about 22 per cent. of its weight of ordinary clay. During the process, the carbonic acid gas is totally expelled, there is formed a combination of silicates and aluminates of lime, $SiO_3 3CaO + Al_2O_3 SiO_3 CaO$, and this calcined mass, being ground to an absolutely impalpable fineness, is transformed, under the influence of moisture, into hydrated double silicates and aluminates, upon which water is powerless to exercise any action.

The best conditions for good cement manufacture are doubtless fulfilled in regions possessing readily available quantities of pure limestone and river clay, containing small percentages of iron and various alkalies. Failing these, pure chalk and ordinary clay will generally answer all purposes; but it will be necessary in their case to introduce into the mixture, before it is kilned, about 1 per cent. of common salt. From the point of view of successful manufacture, however, it is most essential to maintain unvarying quality and proportion in the materials employed. And this can easily be accomplished by chemical analysis. From the consumer's standpoint, the most necessary precaution, after the analysis and trials of its breaking strain, is to guard against the unfortunate and too common practice of using a cement directly from the sacks instead of first spreading it upon a clean and dry surface and allowing it to remain for a couple of days exposed to the action of the elements of the air.

If, however, chemical analyses were more frequently resorted to by manufacturers, and allowed to take the place of "rule of thumb" methods, we should soon hear no more of "cement" containing free lime or free magnesia, for it is very evident that a compound, possessing either, is devoid of the very virtues which of all others it is intended to possess and is not cement at all.—*Engineering and Mining Journal.*

Accidents on East Indian Railroads.

(From the *Indian Railway Service Gazette.*)

THE return of railroad accidents in India for the third quarter of 1886 rather dissipates the idea that mishaps are few and far between in this country. Altogether there were 678 accidents of various descriptions in the three months, the number being slightly below that for the corresponding period of the previous year. The East Indian shows a decrease of 18, the Rajputana-Malwa of 22, the Southern Mahratta of 15, the Great Indian Peninsula of 26, and the Bengal & Northwestern of 21. On the other hand, there were 16 more accidents on the Jorhat, 12 on the Madras, 20 on the Oudh & Rohilkhund, which is not perhaps to be wondered at, and 20 on the Assam. Cattle seem to have been responsible for a considerable proportion of the total casualties. On the Madras Railway there were 19 accidents owing to animals wandering on the line, on the Oudh & Rohilkhund 39, on the Great Indian Peninsula 8, on the Rajputana-Malwa, 43 (or 15.69 per cent. of the total of 274), and on the Bengal & Northwestern, 6. The number of cases in which passenger trains or parts of them left the rails decreased from 30 to 21, or by nine, owing, it is noticed, to there having been no mishaps under this head on the Bengal & Northwestern and the Eastern Bengal railways, against nine and three respectively in the corresponding quarter of 1885. In the number of cases in which goods trains, parts of them, or engines left the rails, there was, however, an increase from 58 to 84, nine more accidents of this kind occurring on the Northwestern Railway, 6 more on the Cawnpore-Achnera State Railway, 7 more on the Jorhas State Railway, and 11 more on the Assam Railway. It i noteworthy that during the quarter under review not a single casualty of this description occurred on the Bengal & Northwestern line, although there were 14 in the corresponding three months of the previous year. There were 19 cases of the bursting of tubes of engines, 61 of the failure of machinery and springs of engines, and 36 of the failure of couplings. The number of cases of flooding of portions of the permanent way was largest on the Great Indian Peninsula, which returned 8 out of a total of 31. Under this head there was a decrease on the Rajputana-Malwa and Northwestern from 13 to 9 and 14 to 7 respectively. The cases of slips in cuttings or embankments show the satisfactory decrease of 17 to 3, owing

chiefly to no accidents of this description occurring on the East Indian Railway. The cases of fire in trains were most numerous on the Northwestern, the number being 13 (or 65 of the total), but as compared with the corresponding previous quarter there was a decrease of 4 on the line, and the total for all India shows a decrease of 12.

Coming to casualties to passengers and others, we find that 111 persons were killed and 202 injured through causes connected with the working of trains. Sixteen more are reported to have been killed and 49 injured in yards and workshops, and 130 to have met their deaths in carriages and at stations from causes unconnected with the working of trains. From causes beyond their own control, 1 passenger was killed and 10 injured, whilst from misconduct or want of caution 7 were killed and 36 injured. Among servants, the numbers were 3 and 18 and 41 and 115 respectively. Two persons were killed and 2 injured whilst passing at level crossings, and 49 were killed and 17 injured while trespassing on the line. Six people committed suicide, and 2 more were killed and 4 injured from miscellaneous causes.

Electric Street Railroads in Europe.

[From the *English Mechanic*.]

THERE can be no doubt that if it were not for the red tape which hampers every enterprise in this country we might by this time have had more practical experience of the utility of electric locomotion than we can obtain from the successful experiments at Blackpool, Brighton, and at Port Rush in Ireland. In the United States electric tramways are at work in many of the larger cities, and preparations are being made for widely extending the new method of traction: while on the Continent of Europe there are at least three tramway schemes which are not only practically but financially successful. So long ago as May, 1881, an electric tramway was opened near Berlin, and traffic has been regularly carried on during the six years, without a mishap of any importance, although the average speed is 12 miles an hour. The line has always been regarded more as an experiment than as a type to be permanently adopted, and for that reason cars with different kinds of gearing have been tried, not for a few months, but in regular work for several years in order to test the durability of the mechanism adopted. It is well known that to obtain a high degree of economy an electric motor must run with great velocity, which must be greatly reduced by the time its motion is transmitted to the driving axles of a tramway car; methods of doing that form the subjects of several patents, and it may be that the best arrangement has not been devised. In a highly interesting paper on the subject read last week before the Society of Arts by Mr. Reckenzaun, a gentleman practically acquainted with all the minute details of electric locomotion, the author said it seems an easy thing to the uninitiated to reduce 800 revolutions of one shaft to 80 of another; but when it has to be done in connection with a tramcar, a vehicle on which space is limited, noise objectionable, and dirt and dust in abundance, one obstacle after another crops up to disappoint the inventor who imagines he has solved the problem. On the Berlin-Lichterfeld line one of the cars has run 76,000 miles since the opening, and has pulleys on the motor-shaft and car axles with V-grooves in which run cords of spiral steel wires. The cords are made by winding a pair of wires closely on a mandrel rather less than ⅛ in. in diameter, so that the finished cord is a flexible spiral having an external diameter of barely 7-32 in. This device, it seems, works without noise or vibration, though some little difficulty is experienced in adjusting the cords upon the pulleys; for if too tight they will break at the joints, and if too loose slip at starting—not a disadvantage, as that is the most trying moment in all gearing driven by electro-motors. Other devices are employed, such as the pitch-chain, but the spiral cords seem to be the best. On Mr. Volk's line at Brighton, belts made of leather links are used; the armature shaft, with a 5-in. pully driving a countershaft with a 24-in. pulley, from which the belt is taken to the driving axle. The belts slip a little at starting, but that eases the motor; while, if necessary, the countershaft being carried in adjustable bearings, the belts can be made as tight as desired. The expense per car mile of this line, the prime mover of which is a gas-engine using gas at 3s. 3d. per 1,000 cubic feet, is only 2d.—a figure which is below that which Mr. Reckenzaun gives as possible when the most efficient machines are employed —viz., 3d. The Brighton arrangements are, however, scarcely suitable for ordinary tramcar traffic, as there is no mud to contend with, and the ordinary rails serve as conductors of the current. It should also be noted that each car last year made no fewer than 23,475 miles, and but for opposition in certain quarters the Brighton electric tramway would be a success in every sense of the term. Of lines worked by overhead conductors the most carefully constructed, if not the most important, is that arranged on the plan of Messrs. Siemens and Halske at Mödling, near Vienna. It is nearly three miles in length, and, like most other tramways in Europe, does nine-tenths of its traffic between April 1 and the end of October, the average cost being 3.42d. per car mile. The average speed permitted is a little over nine miles an hour, and the conductors are slotted tubes carried on posts 18 ft. high and 90 ft. apart, except on sharp curves. The bore of these tubes has to be made perfectly smooth, so as to offer but little resistance to the passage of the contact carriage, which consists of a flexible piece of flat steel carrying three gun-metal pistons made in halves, with springs in the middle, so as to keep the surfaces of pistons and conductor in contact. The pistons require renewal about every two months. Overhead conductors are, however, scarcely suited for electric-tramway work, except in country districts, such as the line just referred to, or that between Frankfort-on-Main and Offenbach, which is 4.1 miles long, and has the slotted overhead tube, and a contact carriage made up of two solid iron pistons, which require renewal every three or four weeks at a cost of one shilling for each carriage. Both the Mödling and the Frankfort cars have spur gearing, and the experience gained with them is not favorable to the further utilization of that means of connecting the motor shaft with the driving axles. For instance, in the Frankfort cars a pinion of 17 teeth on the motor shaft gears into a wheel of 56 teeth on a countershaft, and a pinion of 26 teeth on that drives a wheel of 52 teeth on the axle of the car, giving a ratio of about 6.6 to 1 between the motor and the car wheels. The motor, however, runs at the comparatively low speed of 500 hundred revolutions per minute, and the whole arrangement is heavy, for the train of wheels weighs about 4 cwt., and the total weight of the driving gear for one car is more than 26 cwt. The gearing produces so much noise and vibration that the sensation experienced in the car is anything but agreeable, and the wear and tear are so great that the pinion on the motor shaft wears out in a month, although made of hard gun-metal. Mr. Reckenzaun says that one of the cars is being fitted with wheels having double helical teeth, which are expected to work more smoothly and be more durable; but it may be doubted whether any difference in the shape of the teeth will render toothed gearing tolerable, although it should be mentioned that nearly one million passengers patronized the Frankfort electric tramway last year in spite of the disagreeable noise made by the gearing. On the Port Rush line, the longest electric tramway in the world, pitch-chain gearing is used, and is stated to work satisfactorily, as it does also on the Bessbrook-Newry line. Both these lines are worked by electricity derived primarily from water power, and the cost is respectively 3d. and 4d. per car mile, in the latter case including everything. Mr. Reckenzaun referred briefly to the Blackpool line, and mentioned the systems devised by Profs. Ayrton and Perry, and by Messrs. Pollak and Binswanger, the former having the third rail divided into sections, the connection with the main cable being made automatically by the train as it moves along; and the latter an altogether novel system, in which a powerful magnet under the car attracts, or is supposed to attract, an iron armature in a thoroughly insulated trough beneath

each rail section, which armature when attracted makes contact between the cable and the surface rail, and through the latter with the switch of the car motor. Both systems are ingenious and worth trial; but at present no opinion can be formed of their efficiency, as they exist only on paper. So far we have referred only to lines in which the current is conveyed from a central station to the car throughout the whole length of the tramway; but batteries carried by the car itself are a much earlier device, having been adopted so long ago as 1839, when, of course, they were too expensive, the secondary or storage cell not having come into knowledge then. In order to compare the two systems, Mr. Reckenzaun estimates the efficiency of the conductor and of the secondary battery in the following manner. Taking the tramway at Mödling, the conductor has 2 ohms resistance, 20 ampères of current for each car, and 500 volts E.M.F, at the terminals of the charging dynamo, Supposing only one car running on the line, the waste of energy will be practically nothing at the commencement of its journey; but it will be $20^2 \times 2$ when approaches the furthest end of the line; the average resistance—that due to half the length of the conductor—is 1 ohm, therefore the average loss is only $20^2 \times 1 = 400$ watts against $500 \times 20 = 10{,}000$ watts generated by the dynamo, or a loss of 4 per cent. With six cars on the line equally distributed, however, using 120 ampères, the loss will be 14,400 watts out of 60,000, or 25 per cent.; and so by increasing the number of cars and the current the efficiency becomes less and less. With the accumulators the loss is constant, no matter how long the line, provided the quantity of the stored energy is sufficient for the time, and it matters not how many cars run at the same time on the tramway. The weight to be propelled would be increased, which would entail a corresponding augmentation of power, and therefore a greater consumption of fuel would be the result. But fuel really plays a small part in the total expenditure, and viewed from the standpoint of convenience the propulsion of tram cars by means of secondary batteries is the best system that can be adopted, especially in towns, because it leaves the permanent way in its present simple state. Whether each car should carry its own battery and motor, or an electric locomotive should be used for hauling cars, will depend on circumstances. So far as the neighborhood of London is concerned, it appears that the electric locomotive will be the first system tried, for trips have already been made with the Elieson locomotive on the Romford road out of Stratford, and we presume they will soon be put into regular work. The locomotives and the secondary batteries are ready, and, but for the roundabout ways of Parliament, would have been conveying passengers and earning money long ago. These locomotives weigh, ready for work, about 7 tons; what they will do in the way of hauling cars remains to be proved, but there is not much doubt that they will be cheaper than horse-flesh, and it is certain that they will leave the road as clean as they found it—a point which should not be forgotten in comparing the respective merits of horse and mechanical traction. Sufficient has already been done to show that the cost of electric tramways need not exceed 4d. per car mile, while horses cost from 7d. to 10d.; so that, taking the lowest estimate, there is a saving of one-half, and probably when experience has enabled managers to strike out items which can be dispensed with, the economy may be still more.

As to the gearing for transmitting the power, Mr. Volk believes in the linked leather belts, but Mr. Reckenzaun and others consider the worm arrangement the best; on this point the mechanicians will have something to say, for, if electric tramways are to be introduced, the noise and vibration caused by the gearing will not long be permitted to remain an objection. It may be that the spiral wire cords used for a time on the Berlin line will be found the best arrangement; but it is certain that spur gearing will not do, because, however smoothly it may run when new, it rapidly deteriorates and soon makes so much noise as to be objectionable. There are, however, many methods of transmitting motion which are free from noise, and which only wait an opportunity to assert their superiority in this case.

Formulæ for Weights of Bridges and Depth of Trusses.

THE formulæ given below were presented in a paper read before the American Society of Civil Engineers by Professor A. J. DuBois; in that paper they are supported by an elaborate train of reasoning, and are supplemented by tables calculated on the basis of the formulæ and giving weights, depth of truss, etc., for a number of cases:

DU BOIS FORMULÆ FOR WEIGHTS OF BRIDGES.

For railroad bridges take weight of rails, ties, planking, etc. = 400 lbs. per lineal foot for single track.

Weight of plate girder in pounds =

$$\frac{12\,Wl^2 + 2\,Rld^2}{1.2\,Rd - 12\,l^2} \qquad (1)$$

Here l = span in feet, d = depth in inches, R = average flange stress in pounds per square inch. W = total external load in pounds including allowance for impact.

Economic depth in inches =

$$\frac{10\,l^2}{R} + \sqrt{\frac{6\,W\,l}{R} + \left(\frac{10\,l^2}{R}\right)^2} \qquad (2)$$

Total weight of wind bracing = $N\,(540 + 3.6\,l)$.
Here N = number of panels. l = span in feet.

For bridge trusses:

W_1 = equivalent uniform load per foot per truss due to live load.
W_2 = load per foot per truss due to cross-girders, stringers, rails.
W_3 = load per foot per truss due to wind bracing.
W_4 = weight per foot of one truss, not including bed plates or rollers.

$$W_4 = \frac{W_1 + W_2 + W_3}{\dfrac{3.6\,\mu\,d}{A + \dfrac{\mu\,(45\,p^2 + 202\,a^2)}{(W_1 + W_2 + W_3)\,p}} - 1} \qquad (3)$$

Here d = depth in feet. p = panel length in feet. μ = the numerator of the strut formulæ used. A is found as follows:

For single intersection Pratt truss:

$$A = p^2\,(2\,N^2 + 3\,N - 2) + 3\,d^2\left(2\,N - 4 + \frac{11}{N}\right)$$

For double intersection Whipple truss:

$$A = 2\,p^2\left(N^2 + 3\,N - 10 + \frac{12}{N}\right) + 3\,d^2\left(N - 2 + \frac{16}{N}\right)$$

For Warren girder truss:

$$A = p^2\,(2\,N^2 + \therefore 5\,N - 2) + 6\,N\,d^2.$$

The formulæ for depth of truss is as follows:

Economic depth in feet =

$$\frac{l}{N}\sqrt{\frac{\alpha + \dfrac{45\,\mu}{(W_1 + W_2 + W_3)\,p}}{\beta + \dfrac{202\,\mu}{(W_1 + W_2 + W_3)\,p}}} \qquad (4)$$

The depth and weight of the cross girders and bracing can be found by formulæ 1 and 2.

Cruisers for China.—The Chinese Government has recently given an order for six new armed cruisers to a Hong Kong shipbuilding firm. It is not generally known that there are now several establishments in Hong Kong where vessels of 150 ft. long can be built in a substantial manner. The cruisers are to be about 100 ft. long and built for swiftness rather than for fighting qualities, and are for use in Chinese waters, where smuggling is ripe and flourishing owing to the excessive venality of the officials. Nearly all the material for these vessels will be imported from Great Britain.

Manufactures.

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THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 229.)

CHAPTER V.

THE ENGINES.

CYLINDERS.

THE first method of fastening outside cylinders was to bolt them to the smoke-box, which was made of sheet or plate-iron, when the cylinders were steeply inclined, as shown in fig. 17, page 45. This could be done without difficulty, but when they were placed lower down it was necessary to extend the smoke-box downward. The lower part was usually made rectangular in shape, as shown in fig. 140, with a heavy wrought-iron bar, *B B B*, riveted around the inside at the front end. The cylinders were then bolted to the outside of the smoke-box and to the frames *F F*, as shown in the engraving. This method of fastening was first used in 1844.

Inside cylinders were attached to the smoke-box and frames as shown in fig. 141.

The next step, which was taken in 1853, was to make the bottom *B B*, fig. 142, of the smoke-box of a heavy wrought-iron plate. This extended outward so as to rest on top of the frames *F F*. The cylinders were then placed on top of the plate and bolted to it, and to the smoke-box and frames, as shown. A bar, *C C*, with T ends was also placed crosswise between the bar *B B* to keep it apart and stiffen the whole attachment.

In 1865, the arrangement shown in fig. 143 was adopted. The smoke-box in this case was substantially like that shown in fig. 142, but a cast-iron bed, *E E*, was placed between the two frames *F F* and bolted to them by flanges. The smoke-box was then placed on top of the bed-plate and bolted to it. The cylinders were bolted to the bed-plate frame and smoke-box, as shown.

About the same time, the plan represented in fig. 144 was put in use. In this, the smoke-box was made cylindrical and a heavy bed casting, *E E*, with steam and exhaust pipes cast in it, was bolted to it by suitable flanges. The cylinders were then attached to the frames and to this casting, as shown.

In 1871, the plan shown in fig. 145 was adopted. The smoke-box was cylindrical, and one-half the bed-casting was cast with each cylinder. They are bolted together in the center, as shown. This plan is now almost universally used in this country and makes a very neat, strong and satisfactory job.

VALVES AND VALVE-GEARING.

The main valves which were first built by Mr. Rogers were of the ordinary D pattern, and the valve-gearing was a form of hook motion. In some cases, as shown in fig. 14 (page 44), the eccentrics were outside of the journals and wheels. Unfortunately there are no authentic drawings in existence of the various forms of valve-gearing which were at first used. At an early date, Mr. Rogers was impressed with the importance of using steam expansively, and, in 1843 and 1846, he designed and used the valve-gearing shown in fig. 146. It serves to show the thought he was giving at that date to the subject of working steam expansively.

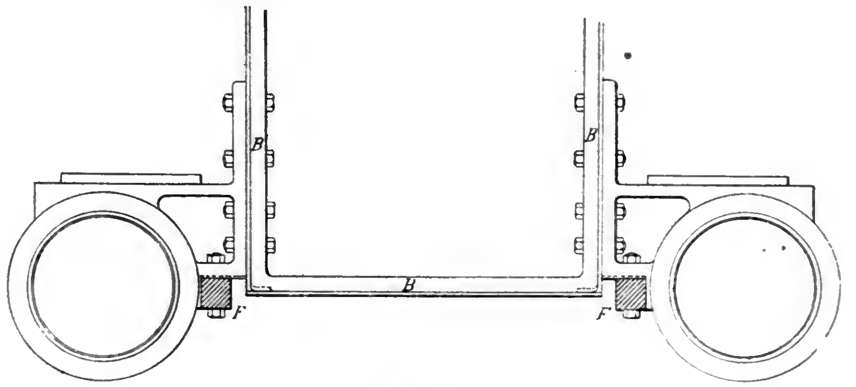


Fig. 140.

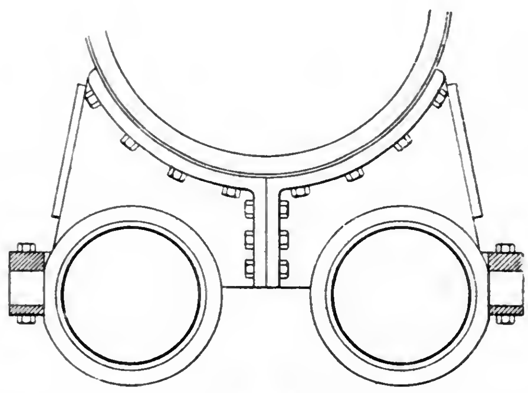


Fig. 141..

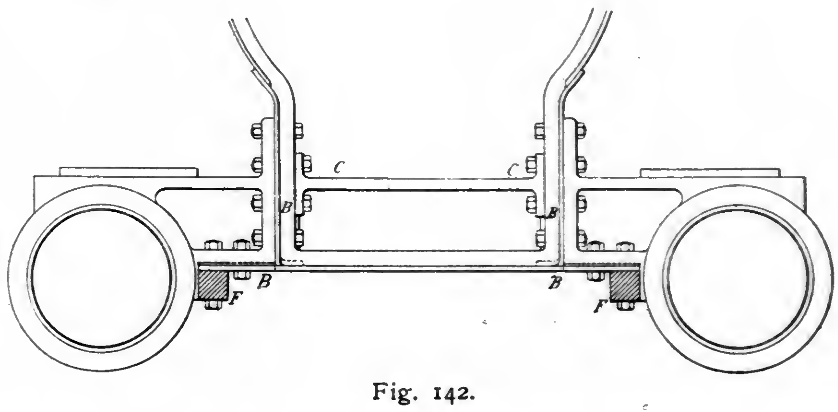


Fig. 142.

Fig. 147 shows another plan, which he introduced in 1847.

When the link-motion was introduced into this country its use was violently opposed by many locomotive builders and master mechanics. Mr. Rogers was one of the first American engineers to recognize its merits. In 1849, he used the suspended link-motion, shown in fig. 148, for some engines for the Hudson River Railroad, and, in 1850, he applied the shifting-link motion, shown in fig. 149, to some engines which he built. It will be noticed that in this case the lifting-shaft was below the link. In the same year he designed the form of link-motion shown by fig. 150 for some ten-wheel engines, the front wheels and axles of which came in the way of the rocking-shaft. In this case the lifting-shaft was above the link.

Fig. 151 represents a combination of link-motion with an independent graduated cut-off valve. It was used on several locomotives built at the Rogers Works in 1854, and, it is said, was found to be beneficial in economizing fuel.

For many years the form of valve-gear shown in fig. 149 was used by Mr. Rogers, and, after his death, it was applied to many engines; but, in 1862, Mr. Hudson designed the form of link-motion shown by fig. 152, in which the lifting-shaft was placed above the link. This is the form which is now most commonly used. The link-motion shown by fig. 153 was also designed the same year by Mr. Hudson and applied to some

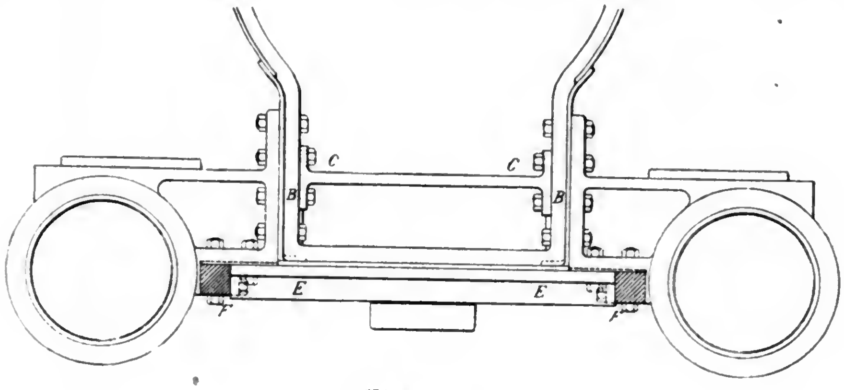


Fig. 143.

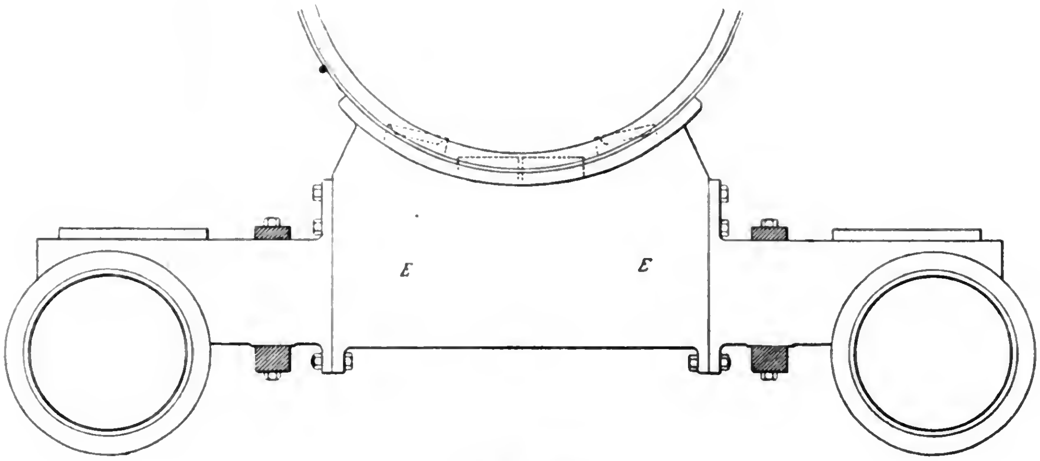


Fig. 144.

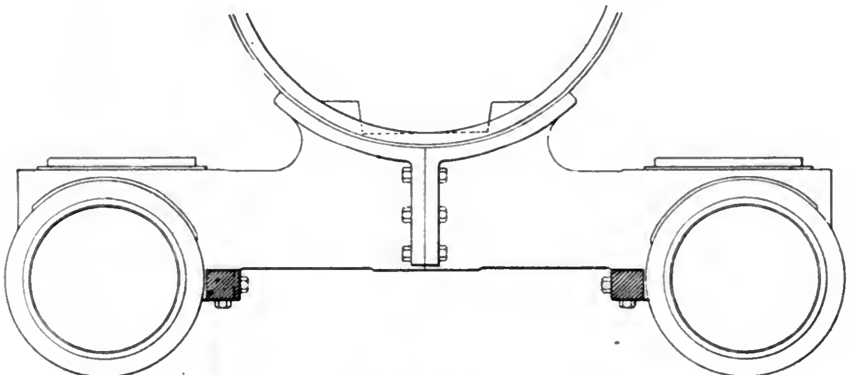


Fig. 145.

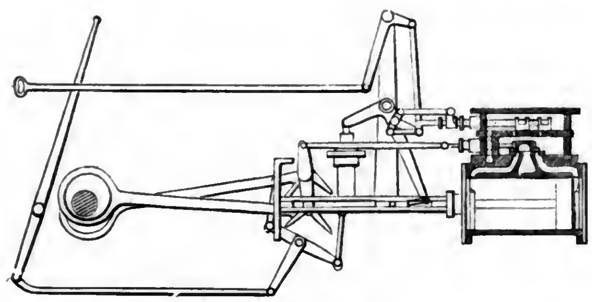


Fig. 146.

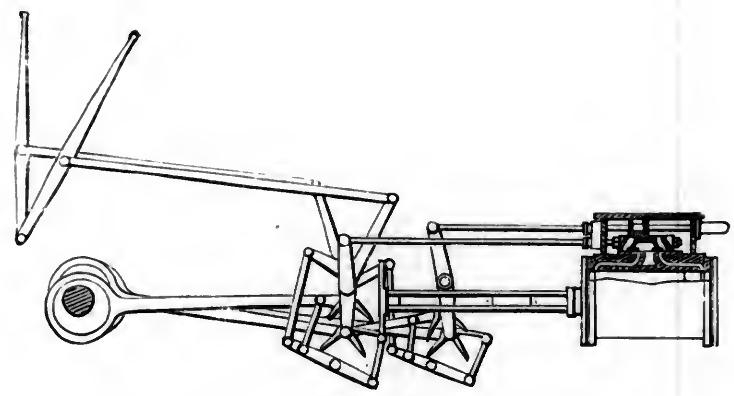


Fig. 147.

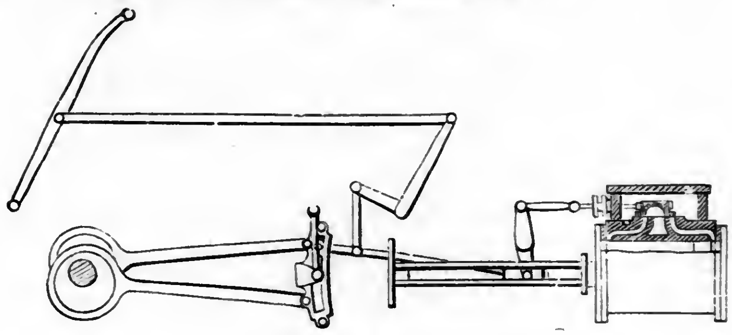
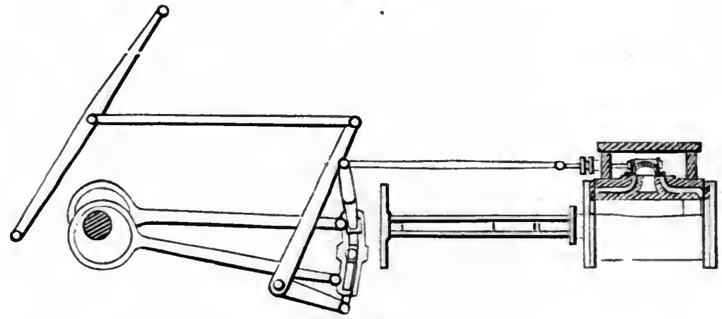


Fig. 148.



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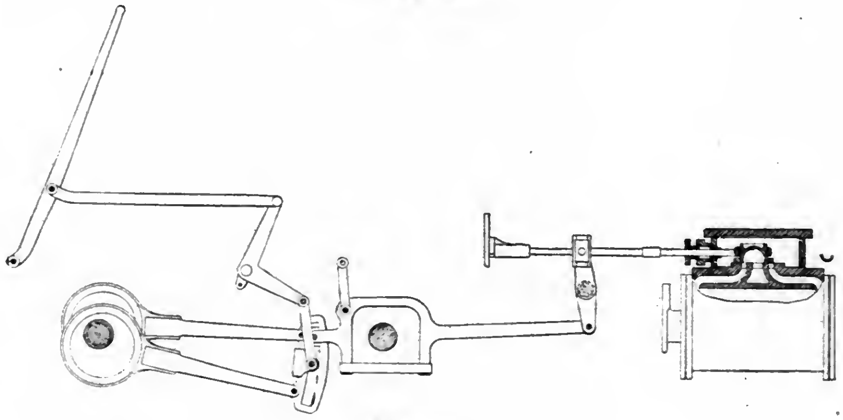

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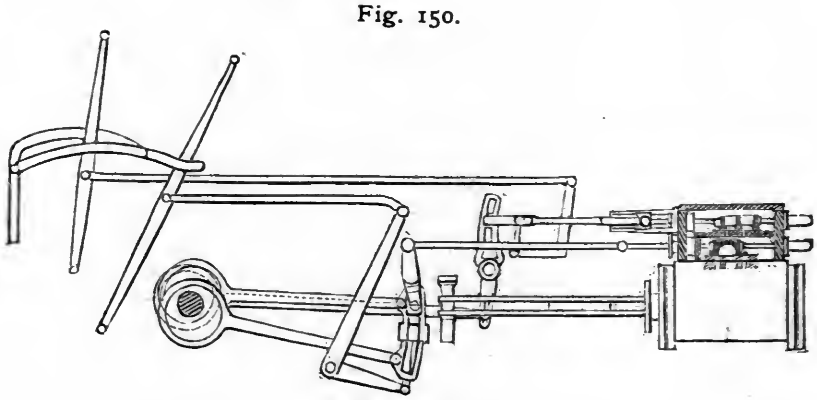


Fig. 151.

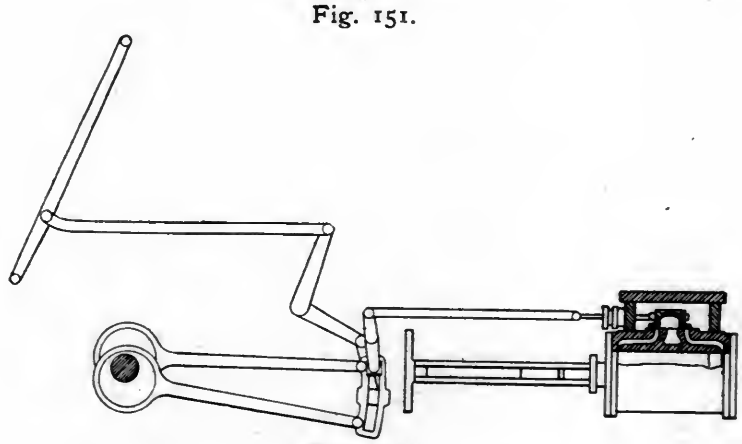


Fig. 152.

ten-wheel engines, in which the front wheels and axle came in the way of the rocking shaft.

In 1866, the valve-gearing shown in fig. 154, which was designed and patented by Messrs. Uhry & Luttgens, was applied to an engine for the Central Railroad of New Jersey. In this there is an ordinary shifting-link worked by two eccentrics and connected with a pin attached to the lower arm of a rocking-

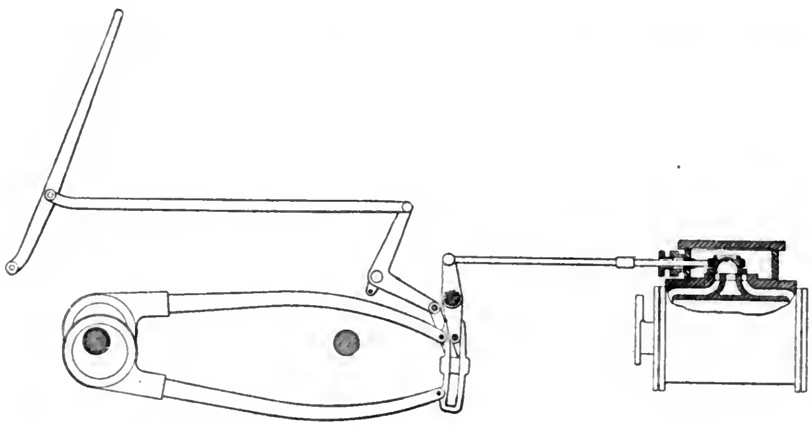


Fig. 153.

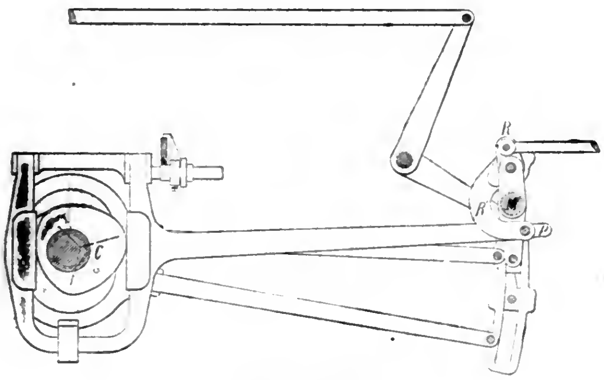


Fig. 154.

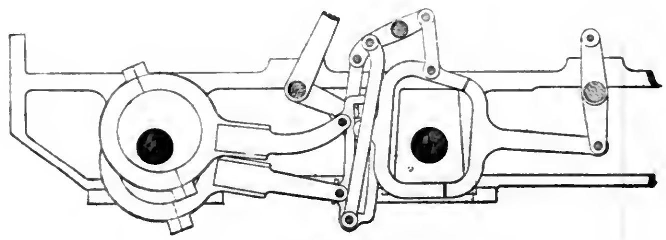


Fig. 155.

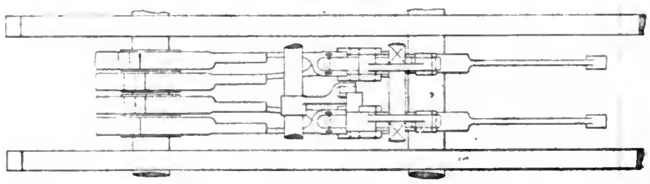


Fig. 156.

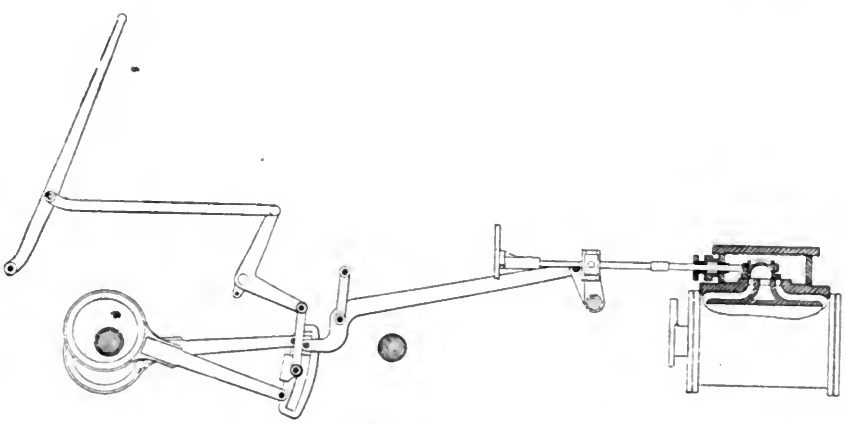


Fig. 157.

shaft in the usual way. What may be called a supplementary rocking-shaft, *R R'*, was pivoted to the top pin of the main rocking-shaft. The lower arm *R'* of the supplementary rocking-shaft is bent into a half-circle, as shown, in order to clear the main rocking-shaft *M*. The supplementary rocker is worked by a cam, *O'*, which was connected to a pin, *P*. The effect of the action of the cam is to accelerate the movement of the valve at the time that it opens the ports for admission and exhaust. Its adjustment is the same as that of the link-motion, and, at the higher grades of expansion, it gives about 50 per cent. greater opening of steam port. The point of exhaust is retarded from 5 to 6 in. beyond the link-motion, while the point of compression remains the same. The size of opening of the exhaust-port is somewhat larger than with the link-motion, and it is opened in less time, thereby producing a strong and clear exhaust.

Its objectionable feature is the cam as a mechanical device for locomotives. Whether this objection would be as great if used with a balanced valve as it is with an ordinary slide-valve remains yet to be proved.

Figs. 155 and 156 show the methods which were adopted in 1873, in applying the Allen link-motion to some narrow-gauge engines for the Patillas Railway, S. A., in which the front axle was in the way. Ordinarily, the Allen link is made straight, but in this case Mr. Hudson found that it would not give a satisfactory movement to the valve without curving the link slightly.

Fig. 157 shows another method of applying a link-motion to engines in which the front axle was in the way. This was used in 1881.

COUNTERWEIGHTS FOR LINKS.

When shifting-links were introduced it became important to counterbalance their weights so as to lessen the effort required to move them. The arrangement shown in fig. 158 was adopted in 1858. In this the counterweight *W* was attached to an arm or bell-crank forged on the reversing lever.

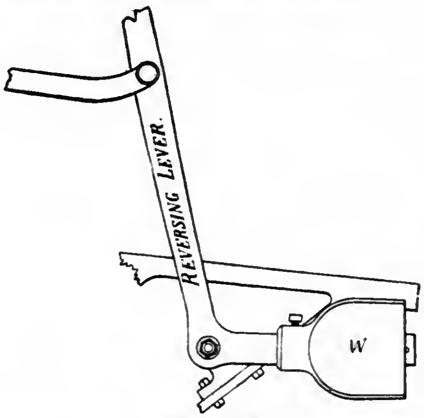


Fig. 158.

The unwieldy character of a counterweight led to the substitution of springs of various forms. The plan shown in fig. 159 was adopted in 1859. In this a half elliptic spring, *S*, which was attached by its ends, *A A*, to fixed parts of the engine, was connected by a rod, *R*, to a short arm, *B*, which was keyed on the lifting-shaft by a strap, *S*, as shown.

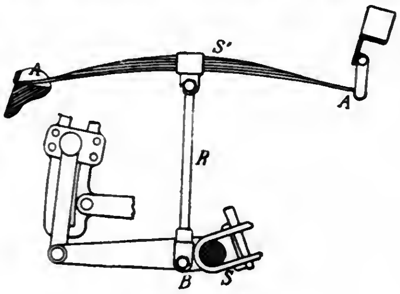


Fig. 159.

Another plan of applying a semi-elliptic spring is shown in plan in fig. 160. In this case the spring *S* was connected to a short arm, *B*, forged on the middle of the lifting-shaft.

In 1860, a spiral spring, figs. 161 and 162, was used. The inner end of this spring was attached to the lifting-shaft *S*, and the other end was fastened to a case in which it was enclosed.

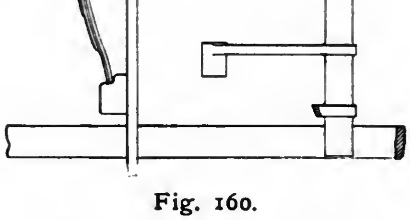
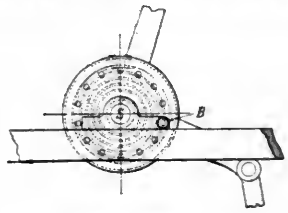


Fig. 160.

The case was prevented from turning by a bolt, *B*. The required amount of tension was brought on the spring by turning the case, and the bolt was adjusted in any one of the holes, which were arranged in a circle, as shown in the engraving.

In 1873, a pair of volute springs was substituted for the semi-elliptic spring. These volute springs are shown in fig. 163. They were enclosed in a case and fastened by a bolt, *B*, to one of the cross-beams, and were connected by a rod, *R*, to a short arm on the lifting-shaft, like that shown in fig. 160. In this instance the rod *R* was subjected to a compressive strain by the tension of the two volute springs.

Fig. 164 shows a helical spring, which was applied in 1875 for the same purpose. This was also enclosed in a cylindrical



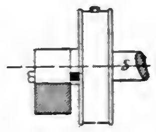


Fig. 161. Fig. 162.

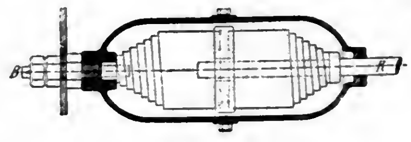


Fig. 163.

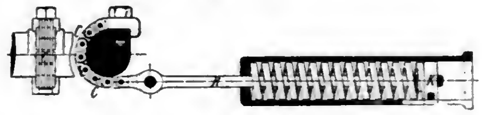


Fig. 164.

case, which was fastened to a fixed part of the engine. A chain, *C C*, was fastened at one end to the shaft, and wound around it as shown. The other end was attached to a rod, *R*, which was screwed into a collar, *K*. When the shaft was turned the spring was compressed. Its tension could be adjusted by means of the screw-end on the rod so as to balance the weight of the link.

(*To be continued.*)

The Miltimore Machine for Dressing Car Wheels.

A NEW machine for dressing and truing up car wheels has been devised and constructed by Mr. George W. Miltimore, of Arlington, Vt. It is based on the principle that a wheel of comparatively soft metal, if moved at very high speed, will wear away the hardest surfaces. The Miltimore machine, as arranged for car wheels, has a disk or wheel, the outer portion of soft steel, 40 in. in diameter and with a face corresponding in shape to the tread of the wheel. This disk is mounted on a shaft 6 in. in diameter and is run at about 2,100 revolutions per minute. The car wheel to be trued up is held in a frame in which it revolves slowly and is fed up to the disk by a combination of friction wheels and screw-feed. The shaft on which the disk is carried is lubricated by means of a pump, which forces oil to the journals at a pressure of about 40 lbs. to the square inch. The disk itself has a wrought iron center, with a screw-thread cut on the surface ; the outer portion or tire, of soft steel, is a ring 2 in. thick, with a screw thread cut on the inside, and is screwed upon the center.

It is claimed that in this machine wheels can be trued up very quickly, and also that the tread is made very hard, a skin or surface being formed which resists the wear of the rails and brake-blocks to a remarkable degree. The advantages gained by truing up chilled wheels are too well known to require any enumeration here.

The soft steel rim of the disk wears very slowly, and it is even said that it increases in size by the accretion of melted particles from the wheels.

An exhibition of one of these machines was given at the factory in Arlington, Vt., recently, a number of railroad officers and wheel-makers being present. At this, steel-tired wheels were trued up in from 7 to 17 minutes, according to the hardness of the tire, while chilled wheels were trued up in from 7 to 10 minutes. The speed of the work depends somewhat, of course, on the amount of power used. It is claimed that a wheel can be dressed in five or six of its own revolutions in the machine.

The machine can, of course, be used for dressing any metallic surfaces by proper arrangement and the use of disks of the proper shape.

Special Tools for Railroad and Repair Shops

(Continued from page 182.)

PORTABLE STEAM-CHEST SEAT MILLING MACHINE.

It is customary, in order to secure a tight joint for the steam-chest when the iron has become corroded to cut a groove the width of the steam-chest sides and then to drive into or fill up the recess or groove just formed with a brass or copper strip. This is a slow and expensive operation, and it is next to impossible to make an even and true surface for the brass or copper joint to rest upon, when using the only accessible tools, *i. e.*, the chisel and file. The portable steam-chest seat milling machine shown in fig. 10 is designed to do this work perfectly, by hand or power, and without skilled labor. It is also adapted to drilling new holes for studs or drilling out old studs when broken off; it can be used as well for milling out the ports on new work and for repairing the same when eaten away.

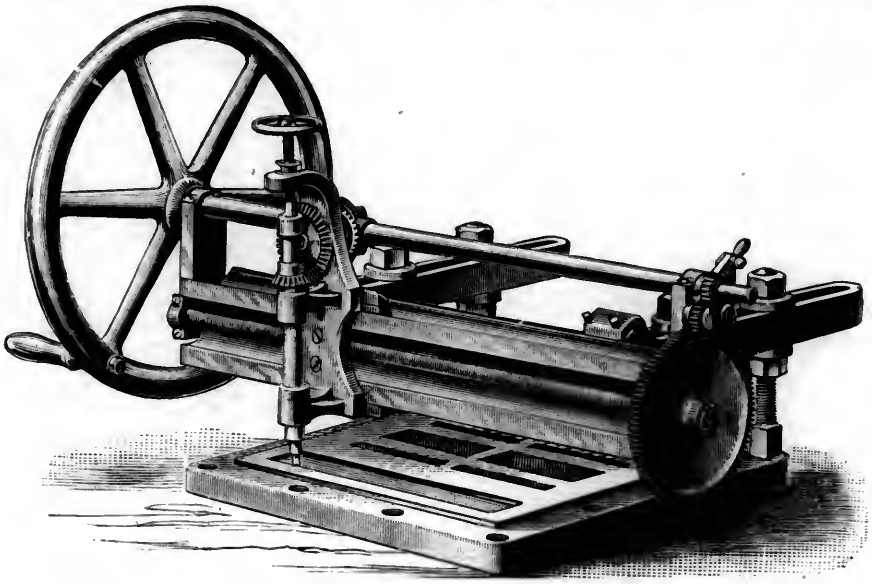


Fig. 10.

STEAM-CHEST SEAT MILLING MACHINE.

The machine is supported and adjusted to the surface to be grooved or milled by four studs running through two hollow arms, which, in turn, support the V's or slide. This slide carries a head containing a spindle similar to a drill press, and this head receives a transverse movement by means of the screw, as shown, the milling spindle being driven by beveled gears and a transverse shaft.

The cutting or grooving is performed by a face-milling cutter inverted in the end of the spindle, which is fed up and down by means of a screw and small wheel, and, when the proper depth for a cut is reached, the horizontal movement of the spindle is prevented by means of a check-nut on the small screw. The sliding or tool-head is fed in either direction by means of change feed-gears at the end of the screw, and, in case of drilling a hole or milling down to the desired depth of a groove, the head can in a moment be made independent of the transverse feed-screw, while the spindle is rotated by the driving-shaft.

It will be seen that advantage has been taken of the limited space afforded for this work in the construction of the machine, and that the strain on the tool-head slide and supporting arms has been reduced to a minimum by bringing the bearing for the spindle within half an inch of the face of the work, thus practically lowering the entire machine as far as possible. But two settings or adjustments of the machine are required for all four sides of the steam-chest seat, because, when the groove is finished on the outer side of the valve-face, all that is required is to loosen the top nuts on the studs supporting and passing through the arms, lift up the machine and replace it facing the boiler, when, having been secured, work can be resumed. The same applies to the other sides, the forward and back ends; after it is set for one and the cut finished, the machine is turned about and replaced on the same studs.

But one size of the machine is built, as provision for very large steam-chest seats is made by supplying extension feet or plates fitted with a T-slot and hole for the ordinary stud. Fig. 11 shows the machine located on the valve-seat of a locomotive, where it is operated by hand.

The machine shown in figs. 12 and 13 is designed for truing up crank-pins when they are cut or worn unevenly. It consists of a casting bored out to receive a revolving cutter-head which carries the tool for the turning; sufficient space is allowed for handling the tools and for chips to fall out. The large end contains a scroll chuck for centering the machine, the jaws of which engage the unworn collar of the pin-centering machine to its original center. On the outer end is a disc containing a spindle operated by a screw similar to a lathe tail stock; this allows a great adjustment, taking in the shortest as well as the longest crank-pins. The center containing the spindle fits exactly into the original center of the pin, holding the outer end true. It is fastened by the four-jawed scroll-

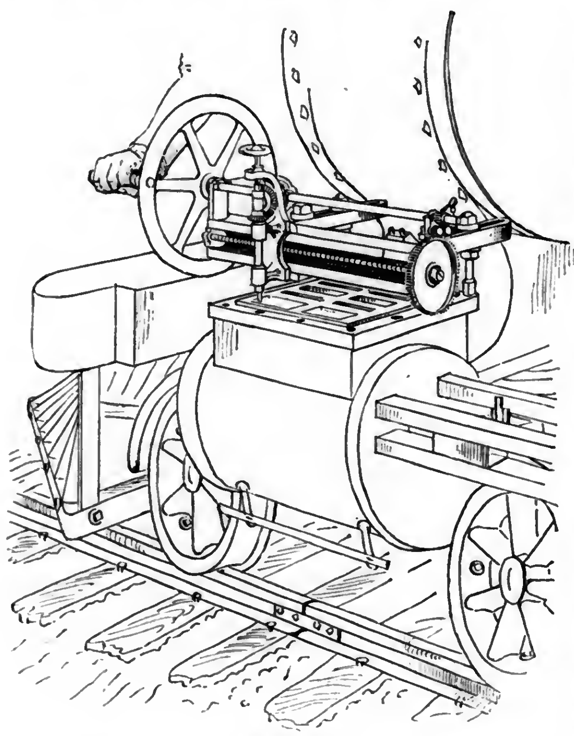


Fig. 11.

STEAM-CHEST SEAT MILLING MACHINE.

chuck on the end next to the wheel, upon which there is no wear, being then clamped in position by two bent or U-clamps to the spokes of the wheel or driver. A triangular feed-casing contains gears, worms and worm-wheels; these admit of feed-

ing either way, as the operator may desire. Tools of various shapes can be made to suit different shaped collars.

The machine, shown by fig. 14, is used for removing the hard adhering crust of lime from the outside surface of boiler flues which is very difficult to remove in a cleaning roller or tumbler, and expensive as well, because of the waste of steam and time. A laborer operates the machine, entering the flues one at a time; they are then revolved and fed through like a screw and drop off on opposite side without assistance. Very little power is required to run the machine. It will clean flues ranging from 1⅞ in. to 3½ in. diameter, removing all scale and without injury to the flue. It occupies but little room, is almost noiseless and makes but little dust. It is so constructed that no countershaft is required, being provided with a double clutch-gear, which enables it to be reversed in case of special need, which sets the pulley free. To set the machine, it is only necessary to place it in line with a pulley on the shaft from which power is taken.

Three revolving shafts, provided with circular, blunt-edged, steel cutters, are set obliquely in adjustable boxes, the central line of the flue passing between them; these boxes are connected with a movable ring, governed by a worm-screw, which is operated by the lower hand-wheel, and each of them is provided with a small, adjustable, circular, assisting cutter. with cross teeth, which cuts the line lengthwise; after being cut crosswise by the circular cutting plates on revolving shafts, the scale is consequently reduced to square particles in a rough manner; the same process is repeated by four circular finishing cutters revolved by the flue, two of them being provided with longitudinal teeth, and two with cross teeth, and placed adjustable on the same inclined plane to the extending plate. Having the circular cutters on the revolving shafts on the same inclined plane, the first and second cutters on each shaft will not come in contact with the flue but will afford an easy entrance, acting like a mill, preventing the machine from chocking; there is no sticking, as the cutters are all revolving. To overcome oval places or uneven diameters, the cutters are arranged to give a little, and, when passed, immediately come

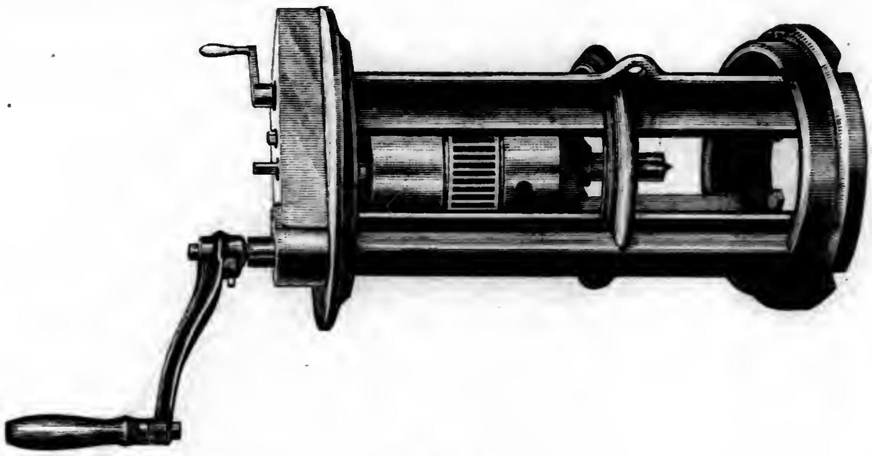


Fig. 12.

PORTABLE CRANK-PIN MACHINE.

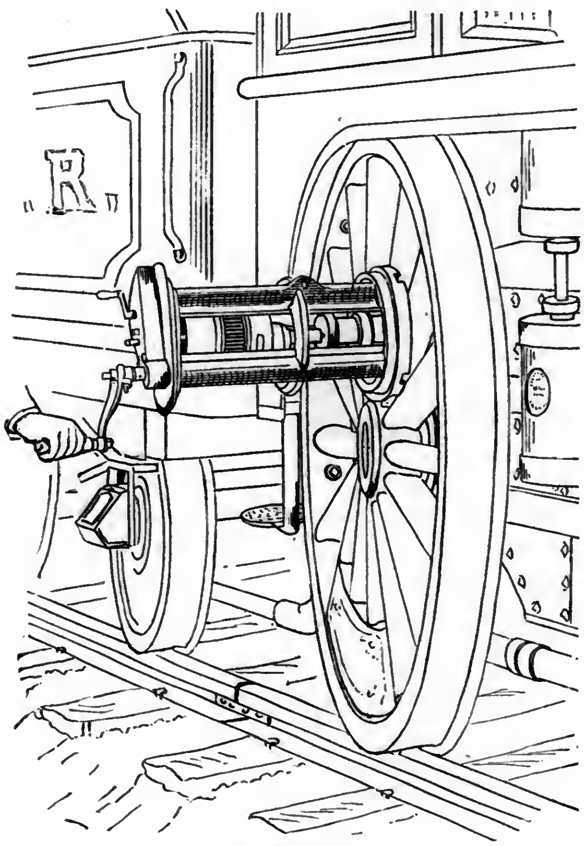


Fig. 13.

PORTABLE CRANK-PIN MACHINE.

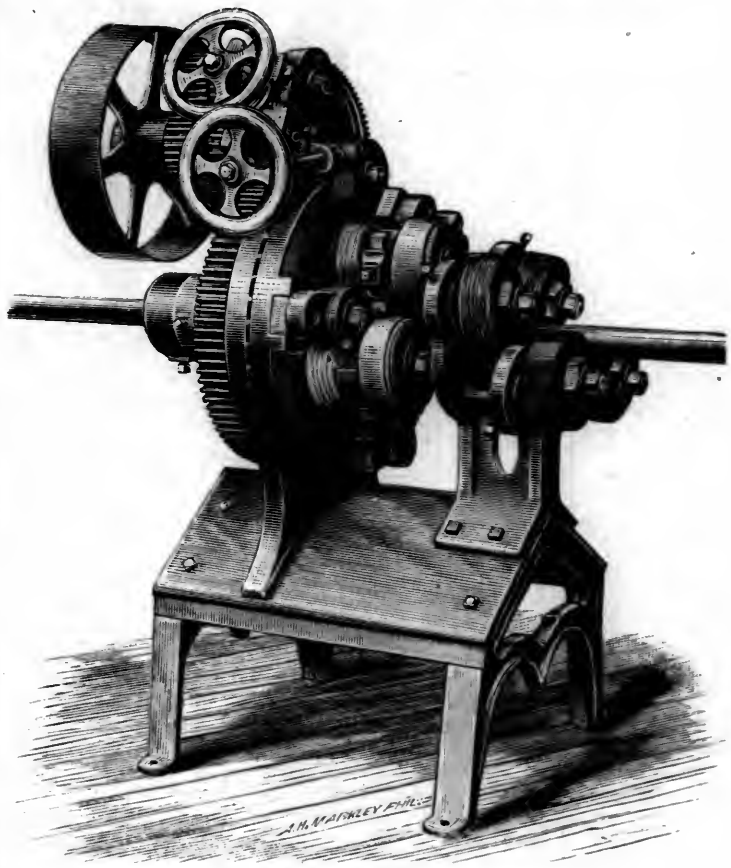


Fig. 14.

ATLAS FLUE-CLEANING MACHINE.

back to the original position, and by a slight movement of the top hand-wheel, the machine can be reversed (or stopped) and the bad place cleaned by passing back and through again. Many flues are not perfectly straight, but as any part of them within the machine is held central in line, the projecting ends are at liberty to swing.

The entrance tube is provided with a set of collars with different sized holes to be inserted alternately, to suit the different diameters of flues, which should be entered in a straight line, to prevent the cutters from being broken.

This machine is strong in all its parts and will stand the hard work it is designed to do; the shafts are protected from dirt and dust with bronze bushings, which can be replaced; the cutters are best tool steel, and are made in duplicates, which can be furnished when desired. The platform of the frame is shaped like a saddle to allow the loose lime to fall off freely. The speed of the machine is optional with the user. The pulley can be run as high as 400 revolutions per minute, when about 6 ft. per minute will be cleaned. At 80 revolutions, it feeds and cleans, on 2-in. tubes, 2 ft. per minute.

In this age of heavy freight and fast passenger service, it is necessary that all the wearing parts of locomotives should be properly attended to and kept in the best kind of repair. The connecting rod and parallel brasses require considerable attention, and, when kept "brass and brass," as termed, fitting the crank-pins properly, there is very little noise and jar. The present manner of keeping them true by filing the faces requires a very expert man and consumes a great amount of time. It is necessary to have the joints or faces of the brasses exactly true with the straps, and, unless they are so when keyed up, they will wear the straps as well as the brasses and become loose, when straps and brasses both have to be replaced. Fig. 15 shows a jointer for facing locomotive brasses, designed to do this particular kind of work by hand or power; it is made so light that two men can carry it to the work. It has an adjustable chuck that catches the brasses, same as the strap does, and holds them, as held on the pin. No more time is required to accurately catch or place the brass in it, than to screw up an ordinary rise. When the carriage containing the chuck is brought up to the cutter, a cut from $\frac{1}{1000}$ to $\frac{1}{8}$ of an inch can be taken off. The cutter used is a single one, placed in a disc adjustable to different diameters; it can be quickly taken out and ground on an ordinary grindstone or emery wheel.

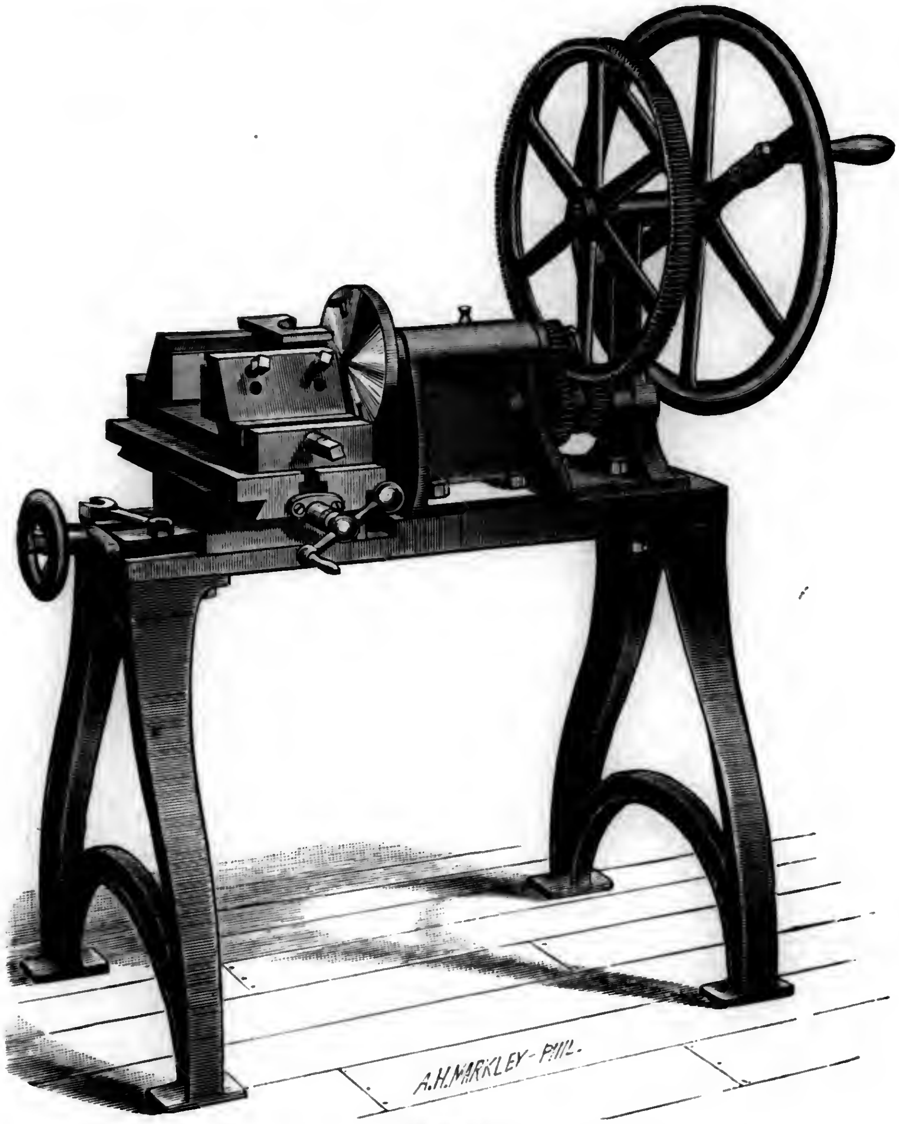


Fig. 15.

JOINTER FOR FACING LOCOMOTIVE BRASSES.

The machine shown in fig. 16 is designed for drilling all the holes in smoke-boxes and cylinder flanges necessary to hang one pair of cylinders, and at one setting of the machine, no previous drilling being necessary. It can be driven by hand or belt power, the latter being preferable for rapid work. It consists of an adjustable, triangular spider at one end, so arranged that by screwing on or off the pointed ends, the center of the machine is central with the smoke-box. This spider supports one end of the machine, the other end being supported by a cross-head, held in position by dogs that clamp firmly to outer edge of the smoke-box.

On this cross head, sliding pieces are arranged to slip to or from the center for different diameters; these sliding pieces have holes in them to hold the dogs and allow for different lengths of smoke-boxes. The drilling-head slides on two parallel rods, on which it can be shifted for any hole to be drilled. These rods are in line with center of smoke-box, and between them is the driving shaft having a bevel gear-wheel fastened to it to drive spindle of the drill, the other end passes through the hub of

driving-pulley, having a key in it working into a spline of the shaft; the drilling head also swings on a bearing, central between the two parallel rods. It requires very little time to set the machine, and, when once set, all the holes can be drilled and reamed parallel and concentric; it need not be stopped to shift from one hole to another, as the shifting is done by sliding the drilling head in or out and swinging from one side to the other. The machine is strong and will carry a 1⅜ drill without any difficulty; the shank is reamed to take more twist-drill taper shanks, into which a reamer shank is fitted.

After the cylinders are in position, an expert man with helper can set the machine, drill and ream all the holes required to bolt the cylinder to boiler in from 4 to 5 hours; this same work, *done without this machine*, takes about 2½ days' time.

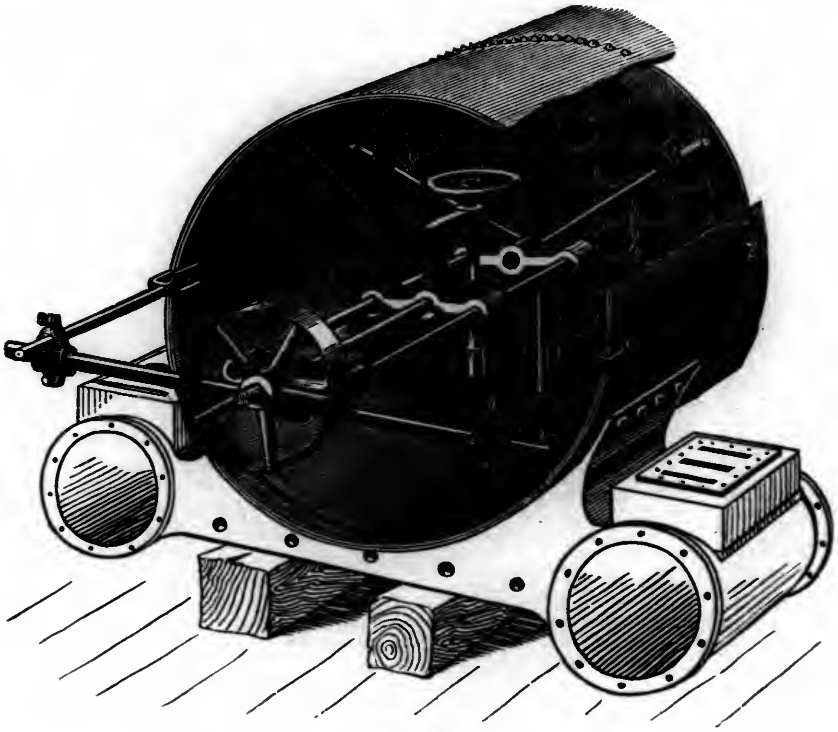


Fig. 16.

RIEPPEL'S PORTABLE DRILLING MACHINE.

The above machines are made by Messrs. Pedrick & Ayer, proprietors of the L. B. Flanders Machine Works, of Philadelphia.

Manufacturing Notes.

THE Lappin Brake Shoe Company, has started up its new works at Bloomfield, N. J., and has already began shipping to fill orders. The works are fitted with every modern improvement for turning out the product with economy and rapidity. The plant has a capacity of 25 tons a day.

The Philadelphia Gas Company has begun the building of extensive works in Pittsburgh for the manufacture of the fixtures, regulators, castings, etc., used in its business. These have heretofore been supplied by the Westinghouse Air Brake Company, but that Company's works are now fully occupied on brake work.

The Pratt & Whitney Company, in Hartford, Conn., is making 150 Gardner improved machine guns for the Italian Government.

The Sanderson Brothers Steel Company is rebuilding and enlarging its works at Syracuse, N. Y., which were recently damaged by fire.

The bridge works of the Chicago Forge & Bolt Company were destroyed by fire May 2. These works were built in 1869 by L. B. Boomer, and were owned successively by the American Bridge Company, Rust & Coolidge, and the present owners. They will be rebuilt.

The buildings of the Paterson Iron Company, at Paterson, N. J., were destroyed by fire May 12, the buildings being burned down and the machinery badly damaged. The Company had an extensive plant for heavy forgings and a rolling mill. The works are to be rebuilt.

The Grant Locomotive Works, of Paterson, N. J., recently shipped through Messrs. Russell & Co., of China, the first locomotive engine ever built in America for use in China. It goes to the Kaiping Railway Company, limited, which controls the Kaiping coal mines, about 75 miles northeast of Tien-tsin, in the province of Chih-li, and has a light railroad of standard gauge, 29 miles long, and used for hauling coal.

The first steel rails ever made in the South were made at the new mill of the Roane Iron Company, in Chattanooga, Tenn., on May 7, last. The mill has now one 5-ton Bessemer converter in operation, and a second converter is to be put in.

Machine for Rolling Car-Wheels.

Theodore W. Bean, of Morisstown, Pa., has recently patented the machine illustrated viz the accompanying engraving, the purpose of which is "to produce car-wheels of rolled and compressed steel."

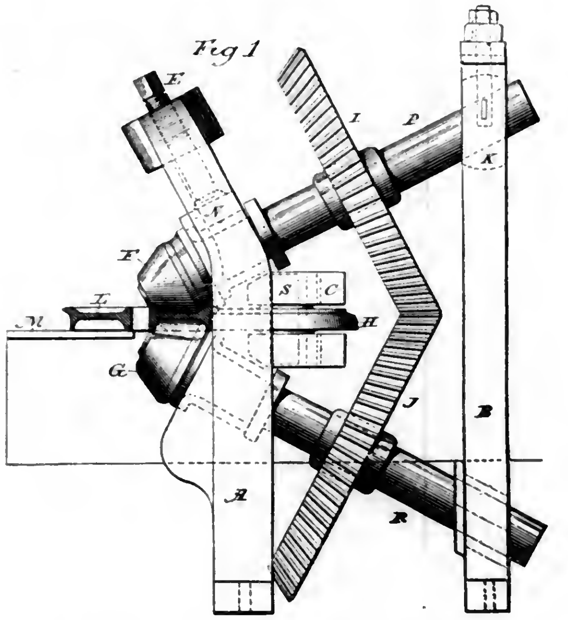
The engraving shows a side view of the machine, *F* and *G* are two roll-heads attached to shafts *R* and *P*. The roll-heads are so shaped as to give the desired form to the steel ingot, which is to be compressed by them into the exact size required.

H is another roll whose periphery give the shape to the thread of the wheel. It will be readily noticed that it moves by friction with the ingot, and is not actuated by either of the side rolls.

A and *B* are housings in which the shafts *P* and *R* are journaled. The ball-box *K* in the upper bearing, *B*, supports the extreme end of the shaft *P*, and its construction allows the roll-head at the other end to be raised or lowered while the bearing acts as a stationary pivot. The desired pressure on the roll-head *F* is given by means of the screw *E* on the rider *N* and allows the roll-heads to be separated sufficiently while the steel ingot is be placed between them on the table *M*.

Power is applied to the shaft *R*, which communicates its motive to *P* by the bevel gears *J* and *I*. The ingot of steel having been cast to a suitable shape and heated is placed in

position on the table M between the roll-heads. The screw E forces the rider N on to the roll F, and the steel ing.t is pressed between it and the lower roll, The rolls H and G act as a die, while the upper roll gradually descends and com-



BEAN'S MACHINE FOR ROLLING CAR-WHEELS.

presses the metal, rendering it homogenous throughout and of greater tensile strength.

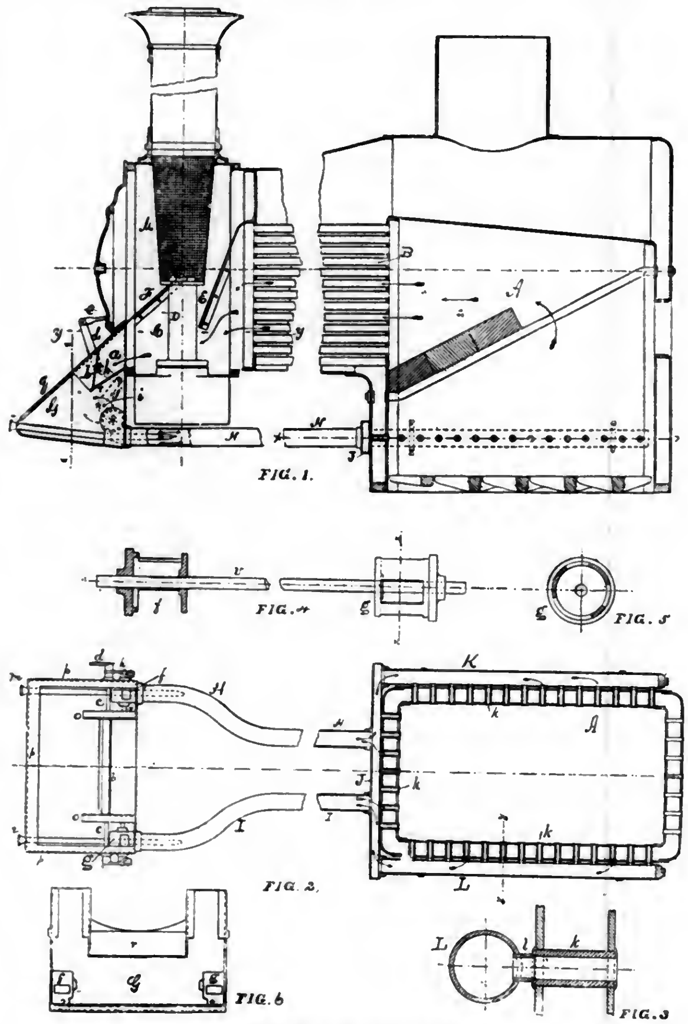
The patent is dated April 19, 1887, and numbered 361,479.

Spark-Arrester for Locomotives.

THE accompanying illustrations represent a spark-arrester, recently patented by William Wilson, of Bloomington, Ill. As will be seen from the engravings, a wire netting is placed in the smoke-box, instead of the stack, and is in the form of a frustum of a cone, extending from the top of the exhaust nozzle to the bottom of the stack. In front of the tubes, and extending below the top of the exhaust nozzle is a deflector E, and another deflector F is placed in front of and below the nozzle. Appended to the lower part of the smoke-box is a receptacle or spark-box G, the opening into which can be closed by a valve. From this spark-box two pipes, $H\ I$, run back to the fire-box, where they connect with the pipes $J\ K\ L$, running along the front and side of the fire-box, and having communications with it through the hollow stay-bolts $k\ k\ k\ k$; an enlarged section of the pipe and stay-bolt are shown in fig. 3. There are further provided two small pipes $m\ m$, opening in front of the spark-box into the air, and extending backward into and a short distance through the large pipes $H\ I$. The pipes $H\ I$, at their entrance into the spark-box, are provided with valves $f\ g$, and these valves are operated by a shaft extending through the spark-box and by a system of levers $d\ h$, which also moves the valve b between the smoke-box and the spark-box.

The operation is as follows: Suppose the valve b to be open and the valves $f\ g$ to be closed, then sparks which pass through the flues will be deflected downward by the diaphragm or deflecting plate E, and, as they move very swiftly, they will be carried across through the smoke-arch and passage a into the spark-box G. The deflecting plate F will have a beneficial effect in aiding to prevent the upward movement of the sparks after they pass the lower end of the deflector E. When the spark-box is full or nearly so, the engineer through the rod e, can close the valve b and at the same time open the valves $f\ g$, and then communication between the smoke-arch and spark-box will be closed, and communication from the spark-box through the passage $H\ I$ to the fire-box will be open. As often as the steam is exhausted air will be drawn through the flues from the fire-box, and at the same time air and the cinders in the spark-box will be drawn through the tubes $H\ I$, chamber J, tubes $K\ L$, and hollow stay-bolts k into the fire-box, to take the place of the air drawn therefrom by the action of the exhaust-steam. At the same time a current of air will pass through the pipes $m\ m$ into the passages $H\ I$, and a strong current of air will pass through the passages $H\ I$, facilitating the withdrawal of the cinders from the spark-box, and also furnishing pure air to the fire-box to promote combustion.

When the spark-box has been emptied, which can be done ordinarily in three or four minutes, the valves $f\ g$ can be closed and the valve b be opened, when the operation will be



WILSON'S SPARK-ARRESTER.

repeated. The spark-box may have a capacity sufficient to hold, say, five or six bushels of cinders.

An opening may be provided in the bottom of the spark-box, through which cinders may be removed in case of any stoppage in the passages leading from the spark-box back to the fire-box. This opening, if provided, will of course be kept closed, except when opened for the purpose of removing cinders.

Mr. Wilson's patent is dated April 26, 1887, and is numbered 361,738.

Proceedings of Societies.

Engineers' Club of St. Louis.

A REGULAR meeting was held in St. Louis, April 20, President Potter in the chair; 16 members and 2 visitors present.

Mr. McMath, Chairman of the Committee on Resolutions on the death of Capt. J. B. Eads, submitted a report which, on vote, was received. It was directed that the report be spread upon the records of the Club, and a copy sent to the family of the deceased.

Prof. Johnson made a verbal report of the recent meeting of the Board of Managers of the Association of Engineering Societies at Chicago. The new arrangements made for the publication of the *Journal* were reported, and its regular appearance in future promised.

Mr. C. W. Clark then read a paper on Experiments with Submerged Adjutages, describing some experiments made at

the University of Illinois. He deduced the results, giving the co-efficient of discharge for each form of adjutage experimented with. The paper was discussed by Prof. Johnson, J. A. Seddon, Russell, Prof. Gale and R. E. McMath.

A paper by Col. E. D. Meier was announced for the next meeting.

THE Club met in St. Louis, May 4, President Potter in the chair, and 12 members present.

Col. E. D. Meier then read a paper on Evaporative Efficiency of Boilers, prefacing his remarks by the statement that he had been unable to complete his investigations, and asking that the present paper be considered as introductory to a more complete discussion which he hoped to be able to present later. Colonel Meier spoke of the duty expected of steam-generating apparatus, and the difficulties met with in reducing the results secured in tests to a common standard for comparison. Some suggestions were made looking toward a suitable standard of comparison. The values of various grades of fuels were touched upon. The relative merits of steel and iron for boiler construction were discussed, the conclusion being that it depended wholly upon proper precautions being taken to make sure that a suitable grade of material is secured. Prof. Potter, Prof. Johnson, Mr. Flad, Mr. Seddon and Mr. Wheeler took part in the discussion.

The President announced the Committee on Smoke Prevention, as now constituted, to be: W. B. Potter, E. D. Meier, H. B. Gale, C. F. White, W. H. Bryan and C. E. Jones. A paper by H. A. Wheeler on the Relative Economy of Machine and Hand-Drilling, was announced for the next meeting.

THE Club met May 18, President Potter in the chair, 21 members and 2 visitors present. J. N. Judson and N. W. Eayrs were elected members.

Mr. R. E. McMath, Chairman of the Committee on National Public Works, made a report stating that no recent progress had been made. On motion the report was received and the committee discharged. Mr. McMath was directed to remit to the Treasurer of the National Committee the funds in hand for that specific purpose and to express to the officers of that body the sentiment of the Club on the subject—which is not favorable to further agitation of the matter at present.

Mr. H. A. Wheeler then read a paper on The Relative Economy of Machine and Hand Drilling. The subject was carefully reviewed, and the various factors entering into the problem were explained and discussed. A comparison based upon results in St. Louis limestone quarries showed an ecoomy of 20 per cent. in favor of the machine. A comparison of work at the Conglomerate Mine showed, in drifting, 5 per cent. in favor of the machine, but in sinking, hand work showed a superiority of 20 per cent. The comparisons were made upon the relative cost per foot of hole drilled, and did not include the factors of quantity of material removed, speed required and ventilation. The value of each of these factors could only be determined by an investigation into the special requirements of each case. They should always receive attention as they have an important bearing on the problem.

The discussion was participated in by Messrs. Holman, Melcher, Seddon, Moore, Potter and Stockett.

The question of the relative cost of mining coal by machine and by hand was also brought up. It was stated by Mr. Stockett that he had accumulated data showing 15 to 20 per cent. economy in favor of the machine. The principal advanage of machine work was its effect on the labor question.

Boston Society of Civil Engineers.

THE Boston Society of Civil Engineers held its regular monthly meeting at its rooms in Boston, May 18, with 43 members and 9 visitors present. Mr. S. E. Tinkham was elected Secretary in place of H. L. Eaton, resigned.

Mr. P. H. Dudley read a long and carefully prepared paper on Woods, their Structure, Decay and Preservation. This was followed by a short discussion, and the Club then adjourned.

Engineers' Club of Kansas City.

AT the regular meeting in Kansas City, Mo., May 2, official notice was received that the Club had been admitted into the Association of Engineering Societies. Messrs. Wm. D. Jenkins, J. F. Wallace, Robert C. Pearsons, M. E. Bowen, E. W. Grant, Wm. Norris and T. F. Wynne were elected members. Mr. Galen W. Pearsons, Chief Engineer of the National Water Works Company, read the paper of the evening, entitled Work with Submarine Armor.

Mr. William H. Breithaupt, consulting engineer, of the firm of Breithaupt & Allen, presented lithographs of the longest continuous girder-bridge yet constructed, at Lachine, Quebec.

Engineers' Club of Philadelphia.

A REGULAR meeting was held in the Club rooms in Philadelphia, President T. M. Cleemann in the chair; 24 members present.

The Secretary presented, for Mr. Edwin Ludlow, Notes on the Preparation of Anthracite Coal. Mr. Ludlow says:

"I desire to call the attention of the members of this Club, and especially those who are mechanical engineers and have the bump of inventiveness well developed, to one of the greatest needs now met with in the preparation of anthracite coal. While engineering ability and mechanical skill have done wonders during the last decade toward putting the mining and preparation of coal on a scientific basis, making it possible to ship as high as 2,600 tons of prepared coal from one breaker in a single day, still in every breaker, no matter how modern it may be, one will find the chutes, through which the coal passes from the screens to the loading-pockets, lined with boys from 12 to 14 years of age, who sit there 10 hours a day, picking by hand the slate from the coal as it passes along. The atmosphere of this screen-room is, in many cases, so laden with fine coal-dust that objects cannot be distinguished 20 ft. away; and while the breathing of this coal dust does not seem to have any immediate effect on the boys' health, it undoubtedly lays the seeds for the bane of the coal region—miners' consumption. It strikes every thoughtful man, who looks down on from 100 to 200 boys working in a single breaker, that it is a very crude and expensive way of preparing coal.

"Various appliances have, of course, been designed, but the only really successful one, as proved by actual experience, has been the water-jig. This undoubtedly removes the slate with a small percentage of waste of coal, and where the product of the mine is wet, and water has to be used on the screens to effect a separation of the dirt from the coal, it is the best and most economical appliance that can be employed. But the greater part of the coal going to market comes from dry mines, where it would be a detriment to the quality of the coal, and a great expense, to use water.

"The waste-water from the jig is also expensive to take care of, as in most localities it is no longer allowable to let it run, with the fine dirt it holds in solution, into the nearest creek, as the sediment will carry a long distance, and invariably deposits itself where it will do the most harm, and entail a heavy suit for damages. Enough tanks have therefore to be provided to allow all the waste-water to thoroughly settle, so that the water and culm can be removed separately. Water itself, or rather the pure article, is both scarce and expensive during a part of each year throughout nearly the whole region.

"And if mine-water is used, as is generally the case, the acid contained in it attacks the iron-work of the jig, and makes frequent repairs necessary.

"The principle the jig works on is based on the difference in specific gravity between coal and slate. The two enter the bottom of the jig together, and, by the pulsations of a large plunger in an adjoining compartment, water is forced up through the coal, lifting it, and allowing a fresh supply to come in. The coal is forced to the top and runs off with the water, while the slate, owing to its greater specific gravity, passes out through a separate opening in the bottom.

"Now, what is needed, and what I hope some member of this Club will devise, is a dry jig, in which this separation will be effected by the use of air instead of water.

"One of the difficulties encountered in getting up such a jig is caused by the care with which coal has to be handled to prevent its chipping or breaking. It cannot be dropped on to iron or wire, or to itself, without producing an appreciable percentage of waste. With the most approved rolls the loss in re-breaking any size to a smaller one amounts to from 10 to 15 per cent.

"While the difference in specific gravity between coal and slate of the same sized pieces is very great, still trouble would be experienced in any separation by an air current with flat pieces of both slate and coal, on which the action of the air would vary, according to whether it acted on the edge or the whole side.

"The man who invents a successful dry jig that will stand the test of actual trial, will undoubtedly make a very handsome thing by it.

"Not to be too cumbersome, a single jig should not have a greater capacity than 500 tons per day, and as the shipping capacity of the anthracite region is about 200,000 tons per day, it would take about 400 to supply the trade.

"I shall always be most happy to furnish any information, or give any assistance in my power to any one desiring to work on the matter."

Mr. J. E. Codman presented a description of a Perpetual Motion Machine, which had been offered by a western correspondent of the Philadelphia Water Department, as a means of supplying Philadelphia with water at an annual running expense of $5 only.

A REGULAR meeting was held at the Club House in Philadelphia, May 7, President T. M. Cleemann in the chair; 19 members present.

The Secretary presented an illustrated paper by Mr. Lewis N. Lukens upon Some Remarkable Breaks in a Reservoir.

Captain S. C. McCorkle exhibited a map of the rivers in the vicinity of New York, made for commercial purposes, and referred to the proposed preparation of a similar map of the rivers in the vicinity of Philadelphia, requesting the discussion of the subject by the Club

It was suggested that the Schuylkill River above Fairmount Dam be included in the survey and plan, as a great convenience to some 1,500 members of the Philadelphia rowing fraternity, but Capt. McCorkle stated that the Government work could not be extended above tidewater.

It was also suggested that it would make the map more generally useful if the streets and other topography were extended across the city or farther inland, instead of, as in the New York map, only showing the wharves, piers and other water-front lines.

The discussion was adjourned and its further continuance is invited.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, May 4, President Worthen in the chair. The following elections were announced : *Members.*—Richard Milford Berrian, Chief Engineer Atlantic Coast, St. Johns & Indian River Railroad, New York City ; John Sterling Deans, Phœnix Bridge Company, Phœnixville, Pa.; John Addison Fulton, Chicago, Santa Fe & California Railroad, Kansas City, Mo.; Wilbur Francis Goodrich, Toledo, St. Louis & Kansas City Railroad, Kokomo, Ind.; John Rogers Hudson, Pomona, Cal.; Frank Adolph Leers, Passaic Rolling Mill, Paterson, N. J.; John George Macklin, Grand Trunk Railway, Peterboro, Ont.; David Lowber Smith, Deputy Commissioner Department of Public Works, New York City. *Associate.*—Robert James Pratt, Electric Manufacturing Co., Troy, N. Y. *Juniors.*—Edgar Bonaparte Gosling, Department of Docks, New York City ; Alfred Milton Mosscrop, Cornell University, Ithaca, N. Y.; Edward Walter Rathbun, Napanee, Tamworth & Quebec Railway, Napanee, Can.; William Plumb Williams, Assistant Engineer Electrical Subway Commission, New York City.

An abstract of a paper by Professor George F. Swain, Massachusetts Institute of Technology, on the Calculation of the Stresses in Bridges for the Actual Concentrated Loads, was read.

A paper was read by J. A. Monroe on a Novel Method of Removing Air from a Vertical Bend in a Suction Pipe. The method described in the paper was the application of a steam-injector to the top of the bend by a direct pipe from the boiler in such a manner as to exhaust the air. By reversing the direction of the steam it could also be used in cold weather to melt any ice forming in the bend.

A discussion took place also on certain questions connected with the testing of cements and the removal or prevention of the efflorescence on walls. As to the latter, Mr. Worthen mentioned the application on brick walls of the soap and alum solutions. Two or three applications of each, externally, caused no discoloration, and absolutely prevented all efflorescence.

A curious case of cement-testing was mentioned by Secretary Bogart, in which a cement showed greater strength at all the ages of mixture, thus far tested, when mixed one of cement to one of sand than when mixed neat.

A CIRCULAR from the Committee of Arrangements gives the following information in relation to the annual convention :

"The convention of 1887 will be held at the Hotel Kaaterskill, New York, beginning about July 2, 1887. The Kaaterskill is one of the largest hotels in the United States. It overlooks many miles of the course of the Hndson River. It is reached directly by rail from Rondout and Kingston, and also by rail from Catskill to the foot of the mountain, and thence by carriage to the hotel. It is contemplated that all those intending to be at the convention should, if possible, meet in New York City, and leave by steamboat on the morning of the day previous to the opening of the convention. The trip up the Hudson will be one of the features of this occasion. A stop will probably be made at West Point, and the works at the bridge over the Hudson at Poughkeepsie will be visited and inspected. The masonry and foundation of the piers and the superstructure of this bridge are in progress. The convention will continue at the hotel several days, including the Fourth of July. Arrangements are contemplated for a visit to the cement rock mines and the cement works of the Rondout Valley (Rosendale), which are near the Kaatersdill. The rate at the hotel will be $3 per day. Ample accommodations are assured. The details of arrangements for the convention, and for transit to and from the place, will be announced in a future circular.

"Members are invited to discuss the subjects presented by the papers which have been published in the transactions since the last convention. In addition to the papers already issued, the following will be ready either in full or in abstract, and will be sent to such members as will notify the committee of their willingness to discuss the subjects presented. Formulas for the Weights of Bridges, A. J. Du Bois ; Vibration of Bridges, S. W. Robinson ; Specifications for Strength of Bridges, J. A. L. Waddell; Calculations of the Strain in Bridges for the Actual Loads, G. F. Swain ; Water Supply, Drainage and Sewerage of the Lawrenceville School, F. S. Odell ; Determination of the Size of Sewers, R. E. McMath ; Anchor Ice, James B. Francis ; Steel, its Properties, its Use in Structures and in Heavy Guns, William Metcalf ; Some Constants of Structural Steel, P. C. Rickets ; Irrigation, Edward Bates Dorsey ; Brick Industry near New York, Calvin Tomkins.

"It is expected that the following subjects, most of them suggested by some of the papers published or received during the past year, will be particularly discussed, and communications upon these subjects are especially invited by the committee.

"The inspection and maintenance of railway structures ; the disposal of sewerage ; recent practice in cable railway propulsion.

"Members of the society are particularly invited by the Committee to transmit their contributions at as early a date as possible, so that suitable arrangements may be made for the disposition of time at the convention. To insure the preparation and preliminary printing of papers or abstracts of papers to be presented at the convention, they must be received at the Society House not later than May 31.

"It is not intended to restrict in any sense the presentation of papers to the subjects above suggested."

A REGULAR meeting was held in New York, May 18.

The Secretary read a paper by Professor A. J. DuBois, giving Rational Formulæ for Weight of Bridges. The writer supported his formulæ (which will be found on another page) by elaborate mathematical reasoning, and supplemented them by tables calculated according to the formulæ.

Written discussions by Messrs. Seaman, Gottlieb, C. J. Morse, H. C. Jennings, E. Thatcher, Hughes, Pegram, Professors Waddell and Ricketts, were read ; also a supplementary article, to close the discussion, by Professor DuBois. There was a short verbal discussion by Messrs. Thomson and C. E. Emery.

The Secretary announced that the party for the annual convention would leave New York on the Albany day boat, July 1. otherwise arrangements would be as heretofore announced.

The Secretary also stated that he would like to receive address of engineers competent to take charge of location and construction of sections or subdivisions of road.

A photograph of the new Manhattan Bridge over the Harlem River was presented by W. R. Hutton. A large piece of sandstone, scaled from Trinity Church, New York, showing marked effects of weather, was exhibited by a member.

New England Railroad Club.

THE regular meeting of this Club was held in Boston, May 11, President Lauder in the ehair. The regular subject for the evening—Axle Bearings, Dust Guards and Lubrication was taken up.

The President opened the discussion by referring to the importance of dust guards, stating that in his opinion almost

all of the wear of journals is produced by foreign matter getting into the box. He showed a journal which had run 36,000 miles on a very dirty road without appreciable wear.

The discussion was continued by Messrs. Chamberlin, Coney, Morse, McKenzie, Adams, Hills and Gohring. Several speakers advocated the use of lead-lined boxes, while others preferred good bronze. The general opinion was expressed that with the weights of cars now in use the M. C. B. standard axle was, if anything, too small, and the President thought that 4 x 8 in. journals would soon be necessary.

After the end of the discussion, the Club adjourned until the second Wednesday in September.

Master Car-Builders' Club.

THE regular meeting was held at the rooms in New York, May 19. The meeting was devoted to the discussion of the Rules Governing the Interchange of Cars. The Club then adjourned until September.

Western Railway Club.

THE regular monthly meeting was held in Chicago, April 20. In the absence of President Scott, Mr. L. E. Johnson occupied the chair.

It was ordered that, as President Scott wished to retire from the Committee on Car Heating, the other two members of the committee be empowered to select the third member, in Mr. Scott's place.

Mr. Crossman, for the Chairman of the Committee, read a report of the Library Committee, which was, on motion, laid over until the September meeting.

Mr. Johnson, Chairmain of the Committee on Interchange Rules, presented a report recommending certain amendments. The report was taken up for discussion and action, but was not completed.

Under Rule 3, Sec. b, Mr. Meade presented a blue-print plan for a gauge differing from the plan given in the present rule in that it gives a definite point for the height of the vertical side of the flange when worn sharp; the leg being also lengthened ¼ in. in order to insert it in a worn tread next to flange. The adoption of this plan of gauge was recommended to the Master Car-Builders' Association.

The Club then adjourned until the third Wednesday of September.

Union Pacific Railway Club.

THIS Club was recently organized at Omaha, Neb., with the following officers: President, John Wilson; Active Vice-President, G. T. Crandell; Honorary Vice-Presidents, S. R. Callaway, G. M. Cumming, T. L. Kimball, S. T. Smith, Erastus Young; Secretary, Charles A. Starr; Treasurer, C. H. Ledlie; Librarian, Walter Carter; Directors, E. Buckingham, C. N. Pratt, H. B. Hodges, G. H. Mumford, George Weigman.

The Club will have rooms in the Headquarters Building of the company in Omaha, where regular meetings will be held on the third Saturday of each month for discussion of subjects connected with railroad operation. About 150 volumes have been secured as a nucleus for a library, which it is hoped to make an extensive one.

All employés of the Union Pacific Railway are eligible to membership in the Club, which has the support of the officers of the Company.

United States Naval Institute.

A MEETING of the Newport Branch was held at the Torpedo Station, Newport, R. I., April 27, to discuss a paper by Passed Assistant Engineer W. M. Parks on Training of Enlisted Men on the Engineers' Force. The author held that it would be far better for the boys when, they enlisted on board the *Minnesota*, to be placed at once in the engine and fire-rooms on that ship and trained to be first-class firemen and machinists, and if this was done the rank of second-class firemen could be abolished.

Captain Arthur R. Yates said that a great deal is involved, especially of time and expense, in training people for the engineers' department, either as firemen or machinists, and I think it would be of great benefit to the service if they could be trained on boaad our training squadron as they will then get a certain amount of military training before going aboard cruising ships.

Lieutenant Edwin K. Moore thought a better plan would be to have the apprentices sent aboard the training ships, and, when qualified for transfer, sent to some school for their apprenticeship as firemen, machinists or whatever capacity they may get in the future in the engineer corps. The boy should receive some training on board a ship before he is capable of doing anything on that ship: to take proper care of himself, his clothes, his hammock, his bag—and a certain amount of seamanship. He would require no more instruction, except in the one profession which he might select for the future. Then, if he could be sent to a steamship and serve a term of apprenticeship he thought it would be better than to take him as a green boy from the street or farm, or whatever place he may come from.

Lieutenant Joseph B. Murdock said that, in the abstract, he fully approved of this paper. He thought that the great necessity of the service to-day is for a higher technical training. Take our new ships. We require something more than ordinary steamships in handling them.

Ensign Geo. W. Denfield said that, according to his recollection, the system of training boys for the engineers' force has been tried and has been given up, one reason for which was that it had a tendency to ruin them physically. He did not think any man should be taken into the engine-room or fire-room until he had reached full growth. The hardships there, which men must endure, cannot be undertaken by boys. If you know what kind of a man you want, an examination will soon show whether he is qualified for the duties he is intended to perform. He was in favor of men being trained on shipboard, but thought they should have a certain amount of knowledge and training which men get on shore. He did not believe in training apprentices, but did believe in training men, in giving them some general idea of what is required of them before going on sea-going ships.

Commander F. J. Higginson said he could not help approving this system of educating. Let the apprentices go into the fire-room on the new cruisers and let them be taught their duties there, and then go into the machine-shops and learn the duties of the machinist.

Lieutenant Karl Rohrer thought the better educated the firemen and shovelers are, the less coal will be burned for the given amount of power. It was a question in his mind whether the fire-room offers sufficient attraction to draw a number of these boys into it after they have almost qualified themselves as seamen. He would take people between 18 and 23 years of age. He did not see why a system of apprenticeship could not be inaugurated to embrace all our naval stations, where boilers and machinery are in constant use, and there train these men in the manipulating of machinery, boilers, tools, etc., and then after three months, draft them on board our sea-going vessels.

Car Accountants' Association.

THIS Association held its twelfth annual convention in Atlanta, Ga., April 19, the sessions continuing on April 20 and 21.

The following officers were chosen: President, T. J. Hoyle; Vice-President, E. C. Spaulding; Secretary, H. H. Lyon; Treasurer, E. M. Horton; Executive Committee, W. A. Moody, G. J. Cook, W. G. Watson.

It was voted to change the name of the organization to the "International Association of Car Accountants," and it was decided to hold the next annual meeting in Montreal, Can., on the third Tuesday in June, 1888.

The time of the convention was taken up by discussions (and reading of papers and committee reports), on Reporting Switched Cars on Interchange Reports; Uniform System of Carding and Routing Foreign Cars; Reporting Destruction of Cars to Owners; Individual Mileage of Cars; Marking Line Cars.

On the last-named subject it was decided not to interfere with the Master Car-Builders' action.

The most important action of the convention was the adoption of a report in favor of abolishing the present rate of ¾ cent per mile for cars, and substituting for it a new rate as follows: ½ cent per mile and 15 cents per day; four-wheel cars one-half that amount. *Per diem* charge to commence on the date of delivery, and no *per diem* charge on cars received and delivered the same day. Line cars not subject to *per diem*, excepting on roads not on the line. *Per diem* not allowed on cars belonging to private car companies. The adoption of a junction report to owners of foreign cars.

A committee was appointed to present this action to the general managers and secure their approval. This action

makes a radical change in the system of charges for use of freight cars.

The convention was largely attended, and much interest was taken in the discussion.

American Institute of Electrical Engineers.

THE fourth annual meeting of this Institute was held in New York, May 3. At the first session, routine business was disposed of and the following officers elected: President, T. C. Martin; Vice-Presidents, Norvin Green, W. A. Anthony, Geo. C. Maynard, Frank L. Pope, R. R. Hazzard and E. Thompson; Secretary, Ralph W. Pope; Treasurer, Geo. M. Phelps.

A second session for discussion and reading of papers was held May 4. It was opened by an address from President Martin. Papers were read by Prof. E. Thompson, on Novel Phenomena of Alternating Currents; E. P. Roberts, on Practical Experience with Storage Batteries; J. H. Powers, on the Insulation of Arc Lighting Plants; Professor W. A. Anthony, on the Differing Diametrical Coefficients of Different Coils of a Fine Rheostat, and on the Change from Negative to Positive of the Temporary Coefficients of some Carbon Flames; D. C. Jackson, on the Best Ratio of the Section of the Gramme Armature to the Section of the Field Magnets; David Brooks, on Lead Encased Conductors.

A resolution was adopted directing the Council to take up the subject of permanent quarters and to proceed at once to solicit subscriptions.

Baltimore & Ohio Employes' Relief Association.

THE report of this Association for the year ending September 30 last shows that the total receipts for the year were \$305,547, and the payments, \$262,059; the cash balance at close of year was \$184,157. The benefits paid to members during the year, and for the 6½ years from the foundation of the Association, were ·

	1886		1880–86	
	No.	Amount.	No.	Amount.
Deaths from Accident	58	\$ 61,000	307	\$ 318,025
Deaths from Natural Causes	103	44,382	621	202,611
Disablements from Accident	2,864	39,116	14,840	193,520
Disablements from Sickness	4,906	73,206	29,342	430,079
Surgical Expenses	1,049	10,990	9,497	63,989
Total	9,580	\$ 228,694	54,607	\$ 1,208,224

The average payment for accidental death has been \$1,036; for natural death, \$326; for accidental injury, \$13; for sickness, \$15; surgical expenses, \$7. The report says:

"The active membership on this date is 20,297; showing an increase, as compared with the previous year, of 4,001. The total number of certificates of membership issued since the inauguration of the Association (May 1, 1880) is 59,107; of which 8,414 were issued during the past year. This increase is due to the opening of the Philadelphia Division, and the insuring of the employés necessary to the operation of that division and to the increase of force employed by the company on its other divisions.

"The medical examination of all persons employed by the company has been continued, as well as the examinations for sight, hearing and color-sense. The result shows that 13,316 were examined as to their physical condition during the year, of whom 986, or 7.44 per cent., were rejected as being unfit for performing the duties required of them. Of the 2,783 persons examined for sight, hearing and color-sense, 171, or 6.14 per cent., were rejected as being deficient to such a degree as to render them dangerous employés for train or other service requiring the use or observation of form or color-signals.

"The distribution of standard remedies inaugurated some years ago has been continued with decidedly beneficial results, they having been placed within the reach of all employés, and their value becoming more and more appreciated by the good results produced.

"The system of sanitary inspection has been kept up, and many improvements in directions affecting the health of your members have been made."

The Saving Fund and Building Feature reports that there were, on September 30, last, 936 depositors, having a total amount of \$356,638 on deposit. The loans of the fund amount to \$227,848. Most of this is on building loans to depositors and other employés, and is repaid in monthly installments. The savings fund assets amount to \$379,576, of which the sum of \$88,617 is in cash and \$55,500 invested.

International Congress of Geologists.

AT a meeting of the American Committee held in Albany, N. Y., in April, a motion was adopted abolishing the Committee of the Whole and its officers, and intrusting the duty of preparing reports on the separate divisions of the geological column to eight reporters, who were thereupon unanimously elected. The following was adopted by the Committee:

"*Resolved*, That we recommend to American geologists the acceptance of the conclusions of the International Congress; said changes to be formulated at a subsequent meeting of the Committee; and it being understood that the Committee will present such additions as are deemed necessary by American geologists to the Congress of London in 1888."

The reporters named, with the assignment to each, are as follows:

Quaternary, Recent, Archæology: Major Powell, Director U. S. Geological Survey, Washington.

Cainozoic (Marine): Professor E. A. Smith, State Geologist, Tuscaloosa, Ala.

Cainozoic (Interior): Professor E. D. Cope, No. 2,102 Pine Street, Philadelphia.

Mesozoic: Professor George H. Cook, State Geologist, Rutger's College, New Brunswick, N. J.

Upper Palæozoic, Carbonic: Professor J. J. Stevenson, University of New York, New York City.

Upper Palæozoic, Devonic: Professor H. S. Williams, Cornell University, Ithaca, N. Y.

Lower Palæozoic: Professor N. H. Winchell, State Geologist, University of Minnesota, Minneapolis, Minn.

Archæan: Dr. Persifor Frazer, No. 201 South Fifth Street, Philadelphia.

Each of these gentlemen is to obtain, for his own subject, the completest possible information from all sources. They all, therefore, unite in soliciting coöperation, suggestions or advice from any of their professional brethren having convictions as to classification, nomenclature, coloration or any of the numerous subjects brought before the last, or likely to be discussed at the next Congress.

The Burlington Brake Tests.

THE second series of tests of freight-train brakes under the direction of the committee of the Master Car-Builders' Association began at Burlington, Ia., May 9. As in the first series of tests, the Chicago, Burlington & Quincy Railroad Company gave the use of its tracks and furnished a pilot to accompany each train, the brake company being required to furnish 50 cars with a locomotive and crew.

The members of the Committee present were G. W. Rhodes, John S. Lentz, Benjamin Welsh and D. H. Neale. There were also present representatives of all the brake companies and a large number of railroad officers and others interested in the trials.

The brakes on the ground at the opening of the tests were the Westinghouse, the Eames, the Carpenter and the Hanscom. The American and the Card brake trains were not quite ready.

The Carpenter and the Hanscom brakes were not in the former tests. The Westinghouse brake train had some improvements over that in use previously, and was also provided with a battery and wires for setting the brakes simultaneously. This electrical apparatus is covered by the Flad patents, now owned by the Westinghouse Company, and can be used or not as desired.

The Westinghouse and the Eames brakes are too well known to require further description here. The Carpenter brake is a straight air-brake, electricity being used to set the brakes, the electrical valve forming an essential part of the apparatus.

The Hanscom is also an air-brake; on this train no driver brake is used on the locomotive.

The Card electric and the American made their appearance late in the tests, but not too late to take full part in the tests.

The general programme laid down by the Committee, with the rules governing the tests, we have given heretofore. The programme has been carried out very much in the order prescribed.

The most notable feature in the tests has been the use of electricity for the purpose of causing the brakes throughout the train to be set simultaneously, or as nearly so as possible.

Mitis Castings.—Mitis castings in wrought-iron or steel are now being successfully manufactured by Messrs. Hansell & Co., at their works in Sheffield, England. The demand has been so great than an extension of the works is contemplated.

PERSONALS.

Mr. John A. Klunk is now Engineer of Water Works at Columbus, Ohio.

Mr. F. B. Hibbard is now Superintendent of the Wilmington & Northern Railroad.

Mr. L. S. Graves has been appointed Superintendent of the St. Louis & Chicago road.

Mr. T. S. Morehead has resigned his position as Chief Engineer of the Wilkesbarre & Western road.

Mr. I. M. DeVarona is engaged in preparing plans for the additional water supply of the City of Albany, N. Y.

Mr. George Bowers has been appointed City Engineer of Lowell, Mass. He has been Assistant for some time.

Mr. A. Gordon Jones has been appointed Superintendent of the Valley Division of the Baltimore & Ohio Railroad.

Mr. I. N. Wilbur has been appointed Master Mechanic of the Hannibal & St. Joseph Railroad at Brookfield, Missouri.

Mr. George Rice, of Philadelphia, has been appointed Constructing Engineer of the Pittsburgh Traction Company.

Mr. R. E. Evenson is appointed Superintendent of the Eastern Division of the New York & New England Railroad.

Mr. S. R. Callaway has resigned his position as Vice-President and General Manager of the Union Pacific Railway.

Mr. W. B. Landreth, of Schenectady, N. Y., has been appointed Engineer to the Sewer Commission of Amsterdam, N. Y.

Mr. James F. Goddard has been appointed General Manager of the Atchison, Topeka & Santa Fe and its controlled lines.

Mr. Robert Moore has been appointed Consulting Engineer of the St. Louis Bridge Company, in place of the late C. Shaler Smith.

Mr. Horace G. Holden has resigned his position as Superintendent of Water Works at Lowell, Mass., after eight years' service.

Mr. L. A. Bowers has resigned his position as Superintendent of the Wilmington & Northern Railroad after 17 years' service.

Mr. Walter F. Randall, of Walton, N. Y., is Chief Engineer of the projected Canastota, Morrisville & Southern Railroad.

Mr. J. G. Chamberlain has been appointed Manager of the Alabama & Tennessee Coal & Iron Company, at Sheffield, Alabama.

Mr. W. P. Savage has been appointed Superintendent of the Southwestern Division of the Central Railroad of Georgia.

Mr. Peyton Randolph has been appointed Assistant General Manager of the East Tennessee, Virginia & Georgia Railroad lines.

Mr. John J. Whalen is appointed Master Mechanic of the Philadelphia & Reading road, with charge of the shops in Reading, Pa.

Mr. J. H. Rankin has been appointed Master Car Builder of the Philadelphia & Reading Railroad with office at Reading, Pa.

Mr. W. B. Parsons, Jr., has been appointed General Manager and Chief Engineer of the Denver Railroad, Land & Coal Company, with office at Denver, Colorado.

Mr. A. A. Jackson is General Superintendent of the New York & New England Railroad, succeeding Mr. William M. Turner, resigned.

Mr. Elliot Holbrook, recently with the New York & New England, has been appointed Chief Engineer of the Pittsburgh & Lake Erie road.

Mr. L. D. Ricketts, late of Leadville, Col., has been appointed Geologist for Wyoming Territory, and will have his office at Cheyenne.

Mr. C. P. Foote has been re-appointed Commissioner of Public Works of the City of Milwaukee, Wis., for another term of three years.

Mr. C. H. Hudson is appointed General Superintendent of the East Tennessee, Virginia & Georgia Railroad, with office in Knoxville, Tenn.

Mr. S. Fisher Morris, late Assistant Engineer on the new Croton Acqueduct, has been appointed Engineer in charge of the Fourth Division.

Mr. Isaac V. Baker, Jr., has been finally confirmed by the Senate as Railroad Commissioner of New York, to succeed Mr. John O'Donnell.

Mr. W. E. Rogers, after a long delay, has been finally confirmed as Railroad Commissioner of New York, thus beginning his second term.

Mr. George S. Allen is appointed Master Mechanic of the Philadelphia & Reading Railroad, with charge of the shops Northern, of Port Clinton.

Mr. Frank D. Moore is now Chief Engineer of the new bridge over the Missouri at Omaha, Neb. He was assistant to the late C. Shaler Smith.

Mr. Charles Pugsley has resigned his position as Chief Assistant Engineer to the Croton Aqueduct Commission, New York, on account of ill health.

Mr. E. A. Van Horne has resigned his position as General Superintendent of the Eastern Division of the Rome, Watertown & Ogdensburg Railroad.

Mr. John S. Kennedy, late with the Pennsylvania Steel Company, has been appointed Manager of the Pulaski Iron Company's Works at Pulaski, Va.

Captain Charles C. Morrison, U. S. A., has been relieved from duty at the Watertown Arsenal and ordered to duty with the Ordnance Board at New York.

Captain John E. Greer, U. S. A., has been ordered to New York to duty as a member of the Ordnance Board and the board for testing rifled cannon.

Mr. W. E. Chamberlain has been appointed Superintendent of the Harlem River Branch of the New York, New Haven & Hartford road. This is a new office.

Mr. A. J. Cromwell is appointed Superintendent of Motive Power for all lines of the Baltimore & Ohio Railroad east of the Ohio River, with office in Baltimore.

Mr. A. G. Kleinbeck, heretofore Superintendent of the St. Louis & Chicago Railroad, is now engineer in charge of the construction of the extension of the road.

Mr. W. H. Harrison has been appointed Superintendent of Motive Power of the Trans-Ohio Divisions of the Baltimore & Ohio Railroad, with office at Newark, Ohio.

Mr. David Lee has been appointed Superintendent of Maintenance of Way of the Trans-Ohio Divisions of the Baltimore & Ohio Railroad, with office at Newark, Ohio.

Mr. A. Hunter Johnson is appointed Engineer of Maintenance of Way of all lines of the Baltimore & Ohio east of the Ohio River. He has his office in Baltimore.

Mr. E. G. Allen, late of the New York & New England, has been appointed Superintendent of the Shore Line Division of the New York, New Haven & Hartford road.

Professor S. P. Langley has been chosen Secretary of the Smithsonian Institute at Washington. He is now connected with the Western University of Pennsylvania.

Mr. Elliott Holbrook is now Chief Engineer of the Pittsburgh & Lake Erie Railroad. He was recently Division Superintendent of the New York & New England.

Mr. E. B. Thomas, General Manager of the Richmond & Danville Railroad, has been appointed General Manager of the East Tennessee, Virginia & Georgia lines also.

Mr. S. T. Smith, for several years past General Superintendent of the Union Pacific, has been appointed General Manager of the Denver & Rio Grande Railway.

Mr. J. F. Holloway, formerly President of the Cuyahoga Steam Furnace Company, of Cleveland, O., has accepted a position with Henry R. Worthington in New York.

Mr. John E. Gleason has been appointed Master Mechanic in charge of the Keyser and Piedmont shops of the Baltimore & Ohio Railroad, in place of Samuel Houston, deceased.

Lieutenant W. H. Jaques has tendered his resignation to the Secretary of the Navy. He will, it is understood, accept an important position with the Bethlehem Iron Company.

Mr. Francis Collingwood has been appointed Chief Engineer of the Chesapeake Dry Dock & Construction Company at Newport News, Va. He will retain his office in New York.

Mr. L. H. Clark, for 10 years past Chief Engineer of the Lake Shore & Michigan Southern, has resigned that position, but will retain a connection with the road as Consulting Engineer.

M. James C. Clarke has finally resigned his position as President of the Illinois Central Company, on account of continued ill health. His successor is Mr. Stuyvesant Fish, late Vice-President.

Mr. Levi Hege, late Superintendent of Road Department of the Louisville & Nashville, has been appointed Superintendent of the Central Railroad of Georgia, in place of F. M. Fonda, deceased.

Mr. C. W. Smith, heretofore Vice-President and General Manager of the Atchison, Topeka & Santa Fe, is now Vice-President only, the duties of the two offices having become too heavy for one man.

Mr. G. W. Cushing, who recently resigned his position as Superintendent of Motive Power of the Northern Pacific, has taken charge of the mechanical department of the Philadelphia & Reading Railroad.

Colonel E. T. D. Myers is now General Superintendent of the Petersburg and the Richmond & Petersburg railroads, as well as of the Richmond, Fredericksburg & Potomac Railroad, with office at Richmond, Va.

Mr. James W. Hill, for nine years past Manager of the mechanical and water works department of Fairbanks & Co., St. Louis, has just resigned his position to become Master Mechanic of the Peoria & Pekin Railroad.

Mr. Harvey Middleton has been appointed Superintendent of Machinery of the Louisville & Nashville Railroad in place of Mr. Reuben Wells, who has gone to the Rogers Locomotive Works. Mr. Middleton was Mr. Wells' assistant.

Captain Charles W. Whipple, U. S. A., heretofore on duty with the Ordnance Board in New York, has been ordered to Leavenworth, Kan., where he will relieve Captain John E. Greer as Chief Ordnance Officer, Department of the Missouri.

Mr. T. R. Hardy has been appointed Chief Engineer of the Lake Shore & Michigan Southern, in place of Mr. L. H. Clark. Mr. Hardy was formerly Chief Engineer of the Boston & Albany, and went to the Lake Shore road in June last as assistant to Mr. Clark.

Mr. Bradford Dunham, late General Manager of the Baltimore & Ohio Railroad, has removed to Montgomery, Ala. He recently became Superintendent of the Capital City Street Railway & Highland Park Company, of Montgomery, but has since purchased on his own account the Montgomery Street Railroad, the consideration being $10,000.

Morison & Corthell is the title of a new firm formed on May 1 to do business as consulting and constructing engineers of bridges, railroads, and river and harbor works in the United States and other countries; to make examinations, reports, plans, specifications and estimates for bridges, and take active charge of their construction; to direct the construction of railroads, or, as experts, examine new routes or proposed branches of existing railroads; to examine, report upon and take charge of river and harbor improvement work for corporations or governments.

The new firm will have its offices at No. 35 Wall Street, New York, and 205 La Salle Street, Chicago. The members—Messrs. George S. Morison and E. L. Corthell—are widely known as engineers of high standing.

Mr. Corthell will retain his position as Chief Engineer of the Atlantic & Pacific Ship Railway.

NOTES AND NEWS.

Elevated Railroads in Cincinnati.—The Cincinnati & Suburban Railroad Company has made application for permission to build an elevated railroad from Fifth and Walnut Streets in Cincinnati, to the city line. The distance is 9 miles and the stations are to be about half a mile apart.

Missouri River Bridges.—Two large bridges are now under erection over the Missouri River, one at Randolph, Mo., for the Chicago, Milwaukee & St. Paul road, and one at Sibley for the Chicavo, Santa Fe & California road. Both of these will be high bridges, 60 ft. above low water mark.

Tunnel at Kansas City.—The Inter-State Railroad Company is building a tunnel about 1,500 ft. long in Kansas City, underneath West Eighth Street. The tunnel will enable the company to extend its tracks into the business center of the city, and make a new connection with the manufacturing district of the city.

Westinghouse Brakes on the Baltimore & Ohio.—The Baltimore & Ohio Railroad Company has closed a contract with the Westinghouse Air Brake Company for the equipment of all its passenger rolling stock with the Westinghouse automatic brake. The Baltimore & Ohio has heretofore used the Loughridge brake chiefly.

New Lake Steamer.—The *Roswell P. Flower* was recently launched from the yard of Wolf & Davidson, at Milwaukee, Wis. The *Flower* is 285 ft. long over all, 38 ft. beam and 22 ft. depth of hold, and has a carrying capacity of 2,400 tons. In addition to her engines she has considerable sailing capacity, and has four masts with fore-and-aft rig.

Pennsylvania Railroad Improvements.—The Pennsylvania Railroad Company will issue $8,000,000 new stock at par, for the purpose of providing for additions to property needed during the current year. The money is to be used as follows: Third and fourth tracks and additional facilities for business, $4,000,000; real estate, $700,000; new branch and auxiliary lines, $2,000,000; new locomotives and passenger equipment, $1,300,000.

New York Elevated Lines.—The Rapid Transit Commissioners have approved the building of lines along the water front by the Manhattan Company as branches of the present elevated system in New York. On the East River side they approved the line asked for, but on the North River side they have allowed a much shorter line than the company desired, turning off from the river at Duane Street and not reaching any of the uptown ferries.

Grade Crossings in Connecticut.—The Legislature of Connecticut has agreed upon a bill for the removal of grade railway crossings. It requires 250 of the more dangerous to be removed at the rate of at least 2 per cent. and not over 10 per cent. a year. The railroads must pay at least 40 per cent. of the cost, and 3 per cent. additional for each 1 per cent. of dividend paid, so that a road paying 10 per cent. dividend would pay 70 per cent. of the cost of the work. The State is to pay the rest.

Ohio Tinplate.—The *Bulletin* of the American Iron and Steel Association says: "The first sheet of tinplate ever made in Ohio was sucessfully manufactured at the Hubbard Tinning Company's works, at Hubbard, on April 10. It has been erroneously stated that this was the first sheet of tinplate ever made in the United States. Tinplates were made between 1873 and 1878 at Wellsville, Ohio, and at Leechburgh and Demmler, Pennsylvania. At these works the black sheets were both manufactured and tinned. The Hubbard enterprise consists simply in tinning imported black sheets."

A Large Shearing Machine.—The Pusey & Jones Company in Wilmington, Del., is making a shearing machine for cutting hot steel blooms for the Old Dominion Iron & Nail Works of Richmond, Va. The machine includes, beside the shears, a rolling table for carrying the blooms from the lifting table to the shears. The shears are thrown in and out of gear by a hydraulic cylinder. The whole machine is driven by an independent engine, with cylinder 8 in. diameter and 12 in. stroke. The shears will cut blooms up to 8 × 8 or by 5 × 15 in., and the whole machine weighs 40 tons.

Car Heating.—The Safety Car Heating & Lighting Company, of New York, has been organized to introduce a new system of heating cars devised by Mr. F. M. Wilder, who is General Manager of the Company. In this system steam from the locomotive passes through a drum under the car, and this drum is so arranged, that a simple connection can be made with hot water or hot air pipes of the heater systems now in use, the steam drum being simply substitnted for the old heater, which can remain in the car. The Company has a flexible coupling of new pattern for making connection between the cars.

Coating Iron with Lead.—Mr. Francis J. Clamer, of the Ajax Metal Company of Philadelphia, has discovered a method of depositing pure lead on iron, steel or other metallic surfaces by which, it is claimed, a perfect union of the metals can be secured. A great number of applications can be suggested for this process, as the lead will protect the iron or steel from rust, the action of acids, etc. Bridge rods and bolts can be thus protected, wires can be covered, and lead-coated iron sheets can be substituted for the lead sheets in the tanks used for making sulphuric acid and for other purposes.

Mr. Clamer has secured his discovery by patents in the United States, Canada and Europe. The Ajax Metal Company will soon be able to supply lead-coated articles to meet any demand.

New Use for Graphite.—The Joseph Dixon Crucible Company, of Jersey City, has introduced a new article called graphite smear-grease, intended to replace red lead in making joints for steam and gas fitting. It is made of properly pulverized and perfectly pure graphite, mixed with best boiled oil. The graphite being a natural lubricant it is claimed that it enables a fitter to make a much tighter and consequently a much more perfect joint. Further, that a joint so made can remain any length of time and will then yield to the ordinary pres-

sure of the tongs. It will make a better joint with less leakage, and render absolutely unnecessary the breaking of joints and couplings, and the straining of tongs. It is equally useful for bolts, screws, etc.

Tunneling the East River.—Last year the New York Legislature directed that certain officers of the New York and Brooklyn City governments should investigate and report this year upon the practicability of a new connection between the cities by bridge or tunnel at or near Grand Street, New York. The report has been made, and is to the effect that either a bridge over or a tunnel under the East River, at the point named, would be practicable, although more room would have to be allowed for the approaches than was specified in the resolutions of the Legislature. On the question whether the building of the connection was needed there was a sharp division. the New York officers all voting against, and the Brooklyn officials for it.

Electric Railroad in Orange.—The Orange Crosstown & Valley Railroad Company is now building a street railroad in Orange, N. J., to be operated by electricity. About half a mile of the line is completed and in operation. Overhead wires are used, power being furnished by a dynamo driven by a 12 H. P. engine at the terminus of the road. The Daft motor is used on the cars. The trolley that is used to take the current from the wires is of a special construction. Two wires are used, one of which is for the return current. The trolley has copper wheels that are insulated from each other, and which run upon the wires, taking the current from one, allowing it to pass down through the motor on the car and thence back through the opposite wheel and wire to the dynamo.

New Jersey Iron Mines.—The iron mines of New Jersey are now more generally employed than for some years past, The Wallace Mine, near Newfoundland, has been re-opened, and heavy shipments are made by Cooper & Hewitt who are working the mine. Cooper & Hewitt also bought, recently, the mines of the Manganese Iron Ore Company, at Sparta, in Sussex County. They are also working their mines at Green Pond and Charlotteburg.

The Bessemer Iron Ore Company, a new organization, is engaged in opening new mines at Oxford, in Warren County. The old Belvidere Mine in Warren County has also been reopened, the water pumped out and the work of raising ore begun. The owners of this mine are building a railroad from the mine to the Lehigh & Hudson River Railroad.

Foreign Patents.—The United States has formally ratified and become a party to the "Convention of Nations for the Protection of Industrial Property," more briefly known as the International Industrial Union. This convention or treaty secures to citizens of the United States the privilege of obtaining valid patents in foreign countries any time within seven months after the patent has been granted here. Heretofore it has been necessary to obtain a patent in other countries on or before the day of its issue in this, in order to secure any protection against infringement. The same privilege is, of course, given by the United States to citizens of other countries in the Union. The countries of the Industrial Union are Belgium, Brazil, France, Great Britain, Guatemala, Holland, Norway, Portugal, Salvador, San Domingo, Servia, Spain, Sweden, Switzerland, Tunis and the United States.

Tunneling Boston Common.—The West End Land Company has submitted to the Boston City Council a plan for a tunnel or tunnels under the Common. The main tunnel proposed will cross the Common from Park Square to Merrimac Street, and the smaller tunnels will run from Beacon Street to Hamilton Place, and from Park Square to Park Street Church. The tunnels will be entirely covered and will not interfere with the surface of the Common, except for a short space at the entrances. The section proposed is 20 ft. wide and 16 ft. high, the arch springing from a point 6 ft. above the floor. Two tracks will be laid. The object of the tunnels is to afford routes for street-car lines to accommodate the Beacon Hill and Back Bay districts, and, by furnishing additional tracks, to relieve the annoying blockades now caused by the concentration of street-car lines on Tremont and Washington Streets.

Chicago, Burlington & Quincy Improvements.—Hereafter, as engines pass through the shops of this road for general repairs, they will be equipped with the extension smoke-box front and straight stack.

The Pullman Works at Pullman, Ill., are building 500 stock cars for the road.

In view of the constantly increasing fruit traffic, the shops at Aurora have begun building some cars to be placed in this special service, running them in passenger trains.

The dining-cars of the road are being fitted with a patent window-screen which, it is claimed, catches all dust and cinder of every kind.

Two of the car-shop's transfer-pits at Aurora are to be fitted with electric power transmission. The Yale & Towne Company, of Stamford, Conn,, and the Edison Electric Light Company, of Chicago, will supply the apparatus.

Copper-plated Steel Sheets.—The *Bulletin* of the American Iron & Steel Association says: "We have received a piece of sheet-steel from Mr. P. H. Laufman, of Pittsburgh, in a condition which indicates a new use for that metal. The sheet is made of decarbonized steel, and is manufactured at the Apollo Sheet-Iron Mills. After being rolled up to the proper thickness it is electroplated with copper on both sides and tinned on one side, and in this condition, it is contended by the manufacturers, it is a better article for many purposes than solid sheet-copper. Mr. P. H. Laufman has been experimenting in this work for years, and has protected his processes by patents. A company has been formed to manufacture the article, called the Pittsburgh Electro-Plating Company, whose office is at 543 Wood Street, Pittsburgh. Mr. P. H. Laufman is Chairman of the company, and Mr. James Benney, Jr., Secretary. The sheet-steel will be furnished to the company by Mr. Laufman's works at Apollo."

Standard Pipe-Threads.—The *Sanitary News* says: "Much has been said in technical journals concerning the necessity for the adoption of a uniform system of pipe-threads in the manufacture of pipe and fittings by different concerns in the country, so that all work would be interchangeable. It may be worthy of remark that the Briggs standard of pipe-threads, which all manufacturers have been urged to adopt, was adopted in 1862 by all the manufacturers of tubes in the United States. At that time Robert Briggs, C. E., was Superintendent of the Pascal Iron Works in Philadelphia, and the gauge he recommended was adopted. The only reason why complaint is now heard is because of the wear of gauges in different factories and the difference in personal equation in their preparation. The manufacturers have really wandered away from their standard adopted 24 years ago, and all that is needed to come back to it is the enforcement of a resolution to do so, which was passed at the meeting of the tube makers at Pittsburgh last October."

Railroad Accidents in Great Britain.—The Board of Trade returns give the number of persons killed and injured on railroads in the United Kingdom during the year 1886 as below:

	Killed.	Injured.	Total.
Passengers:			
In train accidents	8	615	623
Other ways (falling from trains, etc.)	87	727	814
Total passengers	95	1,342	1,437
Railroad Employés:			
In train accidents	4	81	85
Other ways (coupling cars, etc)	421	1,929	2,350
Total employés	425	2,010	2,435
Other persons:			
At highway crossings	81	25	106
Trespassers walking on track	285	91	376
Other causes	52	71	123
Total other persons	418	187	605

The total casualties of all classes include 938 killed and 3,539 hurt, against 957 killed and 3,467 injured in 1885.

A Natural-Gas Company.—The Philadelphia Company, the largest natural-gas company in the United States, reports that on March 31 last its total investment in plant was $8,245,966, of which $496,115 represented cost of gas wells, $1,106,680 charter franchises and patents, and $1,517,305, gas rights and leases; the remaining $5,125,866 being the cost of pipe lines, supplies, fixtures, etc. In addition to the fixed investment, the company had cash and other assets amounting to $615,100. The liabilities included $1,667,503 bills and accounts payable, $357,412, undivided profits, and, $6,336,150, capital stock. The chief items of the company's property were 381 acres owned in fee; 2,285 acres gas rights only owned; leases covering 53,612 acres; 411.87miles of pipe lines and a number of buildings. The company's receipts for the year 1886, were $1,500,161; its working expenses, $355,900; interest and taxes, $186,276, a total of $542,176, leaving a net balance of $957,985. From this 12 per cent. dividends ($621,536) were paid, leaving an undivided balance of $336,449, equal to 5½ per cent. on the stock. Expenditures for new plant amounted to $1,198,657 for the year.

Large Steel Castings.—The Standard Steel Casting Company, whose works are at Thurlow, recently shipped to Messrs. Cramp & Sons, of Philadelphia, a steel stem-casting weighing 15,000 lbs. for a gunboat the latter firm are building for the United States Navy. There was also shipped from the same works a steel stem-casting weighing 13,000 lbs. The

Standard Company has also made for the same firm in Philadelphia 16 propeller-blades for the United States cruisers *Chicago*, *Boston* and *Atlanta*. The diameter of the wheel for the *Chicago* is 15½ ft., that of the wheels for the *Boston* and *Atlanta*, 17 ft. each. The weight of each propeller-blade for the *Chicago* is 2,410 lbs., and for the *Boston* and *Atlanta*, 3,750 lbs. each. The pitch of the wheels is 21, 24 and 24½, respectively. These blades were put to the following tests: They were bolted to a face-plate in a horizontal position, and 30,000 lbs. suspended from the tip-ends of the blades. When the blades were relieved from the weight, they sprang back to place, after a deflection of only $\frac{1}{32}$ in. The stem and stern pieces described are the first ones of cast-steel ever produced in the United States, all others having been forged.

The new St. Lawrence Bridge at Quebec.—The designs for the proposed railroad bridge across the St. Lawrence, at Quebec, have been prepared by Sir James Brunlees and Mr. A. L. Light, M. Inst. C. E., Government Engineer of the Province of Quebec. The St. Lawrence at the point selected is only 2,400 ft. from shore to shore; but, as the great depth of water prevents the construction of piers in the center, the cantilever principle has to be adopted tor the superstructure. Two massive piers of granite masonry will be built at a distance of 500 ft. and 240 ft. from the shores of the river in a depth of about 40 ft. of water, and on these the enormous cantilever ironwork will be erected. The piers will be built sufficiently high to allow the masts of the largest ocean steamers to pass under the center span. The dimensions of the bridge will be as follows:—Length of center cantilever span, 1,442 ft.; length of northern shore span, 487 ft.; length of southern shore span, 487 ft.; total length of bridge and approaches, 3,460 ft.; height from high-water mark to bottom of bridge, 150 ft.; height of piers above high water, 150 ft.; extreme height of top of cantilever above high water, 408 ft. The center span will be 290 ft. shorter than that of the Forth, which has a span of 1,730 ft.

The Cyclone Pulverizer.—A new pulverizer for grinding ores, rock, slag, etc., has recently been exhibited in New York. It is called the "cyclone," and its construction is based upon a principle long familiar to engineers; it consists of an iron drum, in the interior of which revolve in opposite directions, at a very high rate of speed, two hard steel fan-blowers attached to horizontal shafts.

The extremities of these blowers being several inches apart, leave a clear central space for receiving the rough material from a screw feed. The pulverization is effected by the violence and rapidity with which the particles are made to continuously collide or strike against each other, and by the action of the air currents produced by the revolutions, and regulated at will to any degree or intensity, through openings arranged in the drums.

In proportion as to the disintegration takes place from the friction, the resulting powder is drawn—in a state of fineness dependent entirely upon the volume of air admitted through the deflectors—into a series of adjoining chambers, where it is deposited according to its specific gravity; the heaviest in the first, the lighter in the second, the still lighter in the third, and the lightest in the fourth.

Prices of Iron and Steel.—The report of the American Iron & Steel Association gives an interesting table of prices of leading articles of iron and steel, monthly, for three years past. From it we take the following table:

	July,'84.	Jan.,'85.	July,'85.	Jan.,'86.	July,'86.	Jan.,87
Old iron rails at Phila	$ 18.50	$ 17.50	$ 17.25	$ 22.00	$ 19.00	$ 25.25
No. 1 foundry pig, Phila	20.00	18.00	17.75	18.50	18.25	21.50
Gray forge pig, Phila	18.00	16.00	15.00	16.25	16.90	18.50
Gray forge pig, Pittsburgh	17.00	16.25	15.00	16.50	15 75	20.50
Steel rails at Eastern Mills	30.00	27.00	27.25	34.50	34.50	38.50
Best bar (cents per lb.), Phila	2.00	1.80	1.80	1.85	1.90	2.15
Muck bar (cents per lb.), Pittsburgh.	1.70	1.65	1.60	1.70	1.65	2.00
Iron nails (keg.), Pittsburgh	2.20	2.05	2.20	2.50	1.90	2.35

The prices given are the average for the month, and are for a ton of 2,240 lbs., except for bar-iron and nails, which are quoted by the pound and the keg.

With the advance in these prices, the price of iron ore has been put up about 30 per cent., while coke has advanced over 80 per cent.

The Bethelehem Iron Company.—Preparations are well advanced on the new steel plant of this company, which will be one of the best in the world. There is to be a 125-ton hammer, which alone will cost half a million dollars to build. The great hammer at Creusot, in France, is only 100 tons, and until within a short time Krupp's biggest hammer was 50 tons. In addition to the great hammer, the Bethlehem Works will have two of the largest hydraulic presses in the world for bending steel plates and forgings, and also a full set of mschinery manufactured by Whitworth for the compression of steel in a fluid state. One building, 600 ft. in length, to be made of steel and brick, is nearly completed, and other huge structures are on the way. The managers of the Bethlehem Company do not intend to depend upon the Government for maintenance. They believe that, as soon as their new works are in operation, they will have large commercial orders for steel shafting and heavy steel work which will keep them busy. Several millions of dollars are to be invested in the new work, and a combination has been effected with Schneider & Co., of Creusot, in France, by which the Bethelehem Company will have the advantage of the latest machinery and the skilled labor of the great French company in beginning the manufacture of war material on the largest scale in this country.

New Blast Furnaces and Steel Works.—The annual report of the American Iron & Steel Association gives the following lists of blast furnaces and steel plants completed since January 1, 1886, and under contract and building on March 1, 1887:

	Completed.	Building.
Blast Furnaces:		
Charcoal	4	4
Anthracite	.	3
Bituminous and Coke	3	32
Total	7	39
Steel Plants:		
Bessemer	7	9
Clapp-Griffiths	6	2
Open-hearth	9	6
Total	22	17

These tables do not include new furnaces built to replace old ones, or projected plants not actually under contract. The number of furnaces given is the number of stacks.

Of the blast furnaces building, no less than 20 are in Alabama; 5 are in Pennsylvania; 4 in Ohio; 3 in New York; 3 in Tennessee; 2 in Virginia; 1 in Kentucky and 1 in Wisconsin.

Of the new steel plants under contract, 8 are in Pennsyluania; 3 in Illinois; 2 in Indiana; 1 each in Massachusetts, Virginia, Tennessee and Ohio.

There are a number of new furnaces projected, chiefly in Alabama, which have not yet reached the contract point.

Profit Sharing on a Railroad.—A plan presented by President J. M. Ashley has been approved by the stockholders of the Toledo, Ann Arbor & North Michigan Railroad Company, and is to be tried on that road. Its object is to make the employés of the company sharers in its profits. All officials and employés, except the President, are to become beneficiaries of the plan after they have been in the employ of the road five years. In any year in which a dividend is declared each beneficiary is to receive, in addition to his salary, a dividend on the amount of that salary, the same as if he were the owner of that much stock. If any employé or officer is disabled while on duty, so as to be unable to resume his place for six months or more, he is to receive a certificate of paid-up stock equal in amount to the total sum of his wages for the year preceding his disability. In case of a loss of life in active duty, his wife or legal representative is to receive a similar certificate equivalent to five times his last year's wages. Every officer or employé who shall voluntarily retire from the company's service after 20 years' continuous employment, will receive a certificate of paid-up stock equal to the total wages of the last year of his service. This plan of allotment was adopted in the confident belief that it will largely increase the net earnings of the company and promote zeal, economy and general efficiency; that it will also prove itself to be a valuable educator, and teach the necessity of sobriety and fidelity.

Reporting Accidents in Ohio.—The Railroad Commissioner of Ohio has issued the following circular:

"This office is in receipt of a large number of letters requesting interpretations of section 257 of the Revised Statutes of Ohio, to which attention was called by circular letter of April 12.

"In reply to all such I desire to say that the intention of all law is to be operative, and that superintendents of railroads or other officers in charge must promptly notify, by telegraph, the Commissioner of all accidents happening on such railroad or the part of a railroad in this State resulting in the loss of life to any person or persons. 'All accidents' is a term so broad that it must be held to cover all accidents occurring upon

railroad property, whereby human lives are lost, irrespective of their respective causes, and also includes all accidents to persons employed by the railroad company.

"Hereafter reports must be made at once by telegraph, giving if possible the name and the residence of the persons killed. Weekly reports by mail will not suffice. Where it is found that telegraph reports first made did not contain the correct name or residence of the killed, subsequent reports of all information in possession of superintendents or managers must be forwarded by mail as early as possible.

"The State furnishes no blanks on which to make reports, but the information contemplated should give the name, place of residence, name of conductor, number of train and cause of accident, and also state if the person was an employé or not."

Lookout Mountain Inclined Railroad.—The inclined railroad up Lookout Mountain, near Chattanooga, Tenn., is now in full operation. The incline is 4,300 ft. long, rising in that distance about 1,200 ft. The grade varies from 1 in 3 to 1 in 6, the average being 1 in 3½. The track is narrow gauge, and consists of 25-pound steel rails laid on cedar ties and secured by heavy lag-screws, and is well ballasted with stone. There are two heavy curves in the line, but 2,500 ft. being straight. There are three rails in the track, thus making a double-track road. At the place where the up and down cars pass, a fourth rail becomes necessary, so as to make two independent tracks, on which the cars move alternately up and down. The passing points are operated, however, without movable switches.

The propulsion is by cable operated from the foot of the incline. The cable is of special steel, is 1 in. in diameter, with an estimated breaking strength of 50 tons, and a maximum strain of 5 tons. The speed of ascent is about seven miles per hour.

The cars are fitted with a shoe-brake, designed by Major King, operating on the principle so much used in mountainous regions for braking wagons. The brakes are always "on," unless held "off" by the conductor. There is also a system of electric signaling.

At the top of the incline a narrow-gauge line, 1¼ miles long, operated by a tank locomotive weighing 11 tons, takes the visitors to Sunset Rock in nine minutes. The total cost of the line was about $150,000.

The inclined plane and the railroad on the summit were built by a company which owns the land on the mountain and has laid out an extensive park there.

Brooklyn Bridge Improvements.—The Brooklyn Bridge Trustees have adopted a plan for the bridge terminus in New York that was submitted to them by Trustees Clarke and McDonald, which plan was prepared by Charles E. Emery, C. E., of New York.

The plan provides that the promenade shall be continued from the stairway at the New York anchorage by an iron trestle about 15 ft. above the level of the cable road, through the center of the bridge-house, to a platform from which the street can be reached by a double staircase. The promenade entrance will be about 36 ft. above the street, and about level with the top of the elevated railroad station. The present entrance to the promenade will have a broad stairway leading to a platform between the tracks, 19 ft. wide and about 350 ft. long, for the use of outgoing passengers. The parallel of the tracks inside the bridge-house will be continued only to the eastern side of Park Row, and the tracks across the street are to be removed to supply platform and stairway room.

The plan contemplates doing away with switch-engines entirely by putting in duplicate tracks and duplicate cables, one set of which will turn off from the north to the south track about 600 ft. east of the end of the road. Every alternate train will be run upon this track, and discharge its passengers upon the outside platform on the south side of the station. Trains on the other track are to run directly into the station as at present, and discharge their passengers upon the outside platform on the north side; both trains loading from the center platform, that on the south track will proceed directly across the bridge, while the other will cross to the south side by its own cable east of the station. By this scheme only one set of switches will be required.

An American "Bore-Hole."—A correspondent of *The* (London) *Engineer* seems to take it very seriously that the Newcastle Chemical Company, whose works are at Gateshead, has determined to put down a bore-hole for water by what is called the American process.

He says: "It is somewhat strange that in South Durham and North Yorkshire, where so many bore-holes have been made to obtain access to the great salt deposits, that we should be dependent on our transatlantic cousins for the best method of developing our own resources. It appears, however, that the large amount of attention given to boring, and the experience gained in the States in seeking for petroleum oil, has enabled the Americans to know how to operate more quickly and cheaply than we do on this side of the Atlantic. One is immediately struck, when inspecting a sinking on their system, with the extreme simplicity of the apparatus they use. The engine is a good one, though small, having usually only a 12-in. cylinder, and it is afterward retained for working the brine-pump. The boring-rod, which is some 50 ft. or 60 ft. long, in jointed sections, is also well made. All the rest of the machinery is as cheap and crude as it is possible to imagine, but it works well enough, and to make it more expensively would be quite unnecessary. There is only one man and one lad employed on each shift. These do the whole of the work. One shift starts at noon and the other at midnight. Boring by the diamond-drill does not seem to be able to compete at all with the American system, either as regards rapidity or cheapness. One of the chief characteristics of the latter is that, when the hole is complete, and the salt is reached, almost all the appliances are retained in their original position, as, in case of a breakage of the pumping-tube, they may be required again at any time. There seems little doubt but that since boring can be done so cheaply and so expeditiously, it may be usefully employed for many other purposes connected with mining and other branches of engineering."

The Basic Steel Patents.—The *Bulletin* of the American Iron and Steel Association says: "The opinion appears to prevail in some sections of the country that the production of basic steel in the United States has been prevented by the selfishness of the Bessemer Steel Company, Limited, which owns the English patents and has supposed that it also owned Mr. Reese's patents. It is true that, immediately after the Bessemer Steel Company, Limited, acquired the ownership of the English patents, it declined to grant licenses to use them, and for a variety of reasons not now necessary to inquire into or to justify. It is true, also, that, when the controversy with Mr. Reese commenced several years ago, no persons wanted to take licenses from the company unless they were guaranteed against an infringement lawsuit from the other side, which guarantee could not be given. It has thus happened that, down to this day the Bessemer Steel Company, Limited, has not granted a single license, although for several years it has been ready and willing to grant licenses to all persons who would agree to pay a royalty of $1.00 per ton for every ton of melted metal which should be converted into steel by the basic process. It has not advertised this fact because of the legal difficulties with Mr. Reese, which, as we have said, prevented it from guaranteeing possible licences against legal proceedings in Mr. Reesees behalf. But to various applicants it has explained the situation exactly as we have done above. The company is now willing to grant licenses upon the terms mentioned. It would be glad to get back in the shape of loyalties a part of the $300,000 it has paid for the English patents and paid to Mr. Reese, or agreed to pay to him.

"It will be seen that the real difficulty in the granting and accepting of licenses to use the basic process in this country has been an extended legal and troublesome controversy with Mr. Reese, against whom the Bessemer Steel Company, Limited, brought suit many years ago to compel the performance of the contract which it alleged it had made with him. This controversy is now in a fair way of being speedily ended. It is a curious fact that the original or acid Bessemer process was also several years getting a start in this country, owing to a vigorous controversy between two sets of gentlemen, each of which claimed to own the only patents under which Bessemer steel could be made."

Hydraulic Testing Machines.—The Yale & Towne Manufacturing Company, in 1882, acquired control of all the inventions and patents of A. H. Emery, C. E., relating to scales, gauges and testing-machines.

These machines were then already in high repute, by reason of the celebrity acquired by the 400 ton testing-machine designed and built by Mr. Emery for the Government, and located in the United States Arsenal at Watertown, Mass. The reputation thus established has been strengthened and enlarged by the experience acquired with other testing-machines on the Emery system.

Engineers acquainted with the principles of construction of the Emery testing-machines know that the building of these machines involves facilities for working pieces of large size and weight, and necessitates also the ability to manipulate these with a degree of precision and mechanical skill resembling in fineness that required in watch-making and rarely needed or attempted in connection with heavy work. Upon undertaking the building of these machines, the Yale &

Towne Company provided a suitable plant for the purpose, and have built some 10 machines, of capacities ranging from 60,000 up to 300,000 lbs. The plant and organization required for this work, however, is entirely special in this case, and does not harmonize with any of the several and varied classes of products which are manufactured in the works.

While the mechanical results of the business under this company's management have been excellent, the commercial results have, for the reason just stated, been less satisfactory. To remedy this, and at the same time provide for the proper continuance of the business, the company has concluded an agreement with Messrs. William Sellers & Company, Incorporated, of Philadelphia, under which that concern receives an exclusive license in the United States for the building of testing-machines on the Emery system, and have arranged to transfer also the drawings, patterns, special tools, etc., provided in this business.

The Yale & Towne Company retains several finished testing-machines, of 75 and 150 tons capacity, which are for sale. All other business in relation to testing-machines should be transacted with William Sellers & Company.

Natural Gas in the West.—The Cleveland *Iron Trade Review* says: "Whatever the skepticism of the past, there can be no longer any doubt that the district comprising Western Pennsylvania, Ohio, Indiana and adjacent territory is now the producer of the cheapest and most abundant fuel on the face of the globe. Nothing need be said of the magnitude of the natural-gas interest of Western Pennsylvania; the fact that the connections made last year in Pittsburgh by the Philadelphia Company alone aggregated 12,400, against 7,000 the previous year, shows to what proportions the use of the new fuel has grown.

"We have not at hand sufficient data to show the total daily production of gas-wells now flowing in the district above defined, but recent conservative estimates place the flow in the Northwestern Ohio District at not far from 100,000,000 cubic feet per day.

"Not less surprising has been the rapid development of natural-gas territory in Indiana during the past 60 or 90 days. While it cannot be admitted that the strike at Fairmount, Ind., heralded the past week as the 'largest gas-well in the world' is so, nevertheless its estimated flow of 12,000,000 cubic feet per day places it well up alongside the great Karg well of Ohio, and certainly beyond anything that Pennsylvania has yet produced. Other points in Indiana that have been proven to be within the high-pressure gas belt are Kokomo, Muncie, Marion, Noblesville, Mexico, Anderson and Indianapolis. What the next 60 days will bring forth is hard to conjecture.

"A curious thing in regard to the advent of the new fuel is the fact that, while it has displaced thousands of tons of coal in the districts directly within the gas belt, thefigures of production show that, instead of being materially reduced thereby, the output of coal in Western Pennsylvania and Ohio last year was very largely increased. During the first nine months of 1886, there was an increased coal output in the Pittsburgh District of nearly 140,000 tons as compared with the same period in 1886, while the Ohio output in 1886 was 500,000 tons in excess of 1885, aggregating 9,500,000 tons. This clearly shows that new markets have been found for the coal product more than sufficient to make up for the loss sustained to coal producers by the use of natural gas. Not only this, but the competition of the new fuel has resulted in greater economy in the use of coal; so that, even should the supply of gas be diminished, or fail, the cheaper use of coal is assured for all time to come."

Electric Lighting of Cars.—For nearly two months the Connecticut River Railroad has been running a train brilliantly illuminated by electricity supplied by a dynamo which is run by the car wheels. The train consists of two passenger coaches and a combination baggage and smoking car. The dynamo occupies a closet built on one side of the baggage section of the car next the entrance to the smoking apartment. There 16 incandescent lamps of 16-candle power to a car, arranged on each side, and differ from those on the Boston & Albany train in the construction of the film, which is of carbonized silk, instead of bamboo fiber. Attached to the journal at one end of the car is a 12-in. section pulley, over which an iron cable revolves, running a counter shaft, on a slight elevation above, 30 ft. away, by a 16-in. pulley. The cable is 65 ft. long, ½ in. in thickness, and made up of 132 wire strands. Iron rollers suspended from the car draw up the lower and press down on the upper halves of the cable, guiding it and keeping it taut. The cable runs directly in the center of the car, while the belt to the dynamo above is attached to a 36-in. pulley near the outside. This pulley surrounds a 12-in. friction wheel, two shoes grasping it firmly by means of two double springs. Here an ingenious device regulates the speed. As soon as the speed comes up, block governors near the circumference of the swiftly moving wheel fly apart, and with a lever and cam movement the shoes are released from the friction wheel, reducing the speed of the 36-in. wheel surrounding to the required amount. The dynamo is of 5 H. P. and 50-light capacity. From the supply wires leading to the lamps, special wires are stretched off to the storage battery on the opposite side and balancing the car. This battery is of the Julien system, has 24 cells and a storage capacity of 45 volts, being able to light one 16-candle power incandescent lamp 160 ampere hours. When fully charged, it is expected to light 3 cars at least 2 hours. Indicators on the storage boxes and at the dynamo record the voltage of each. When the train is running at full speed an excess of electricity is constantly running to the storage cells, to be ready for service when the station is reached and the wheels stop running. The experiment of utilizing the car wheels for running a dynamo is being conducted by Mr. S. H. Barrett, electrician, and as an economical and practical method of lighting cars by electricity, he is very hopeful for the future of his machine. The entire outfit for fitting up three cars will cost but $600, and the only expense will be in the wear and to replace the incandescent lamps. For lighting three cars the machinery and plant only weighs about 1,000 pounds, and if the battery is doubled for 5 cars it would weigh less than a ton, while on the Boston & Albany Railroad the storage batteries for each car weigh a ton.—*Boston Herald.*

The New Naval Vessels.—The good work of rehabilitating the Navy is slowly progressing. The first frame of the *Baltimore* was raised May 20, and the Messrs. Cramp report the arrival of plenty of material to carry on the work without interruption on both that vessel and Gunboat No. 1. The first carload of material for the *Charleston* arrived at San Francisco last week, and her contractors expect to go on with the work of construction without delay. The Columbia Iron Works of Baltimore, are making good headway in getting out the material for Gunboat No. 2, and will be able to begin work of construction very soon.

At the Navy Department Mr. Whitney is stirring things up to get the plans, specifications, blank forms of proposals and contracts ready for the bidders on the *Newark*, two 19-knot cruisers and two 1,700 ton gunboats. The bids for the construction of these vessels are not to be opened until August 1, but according to the Department's circular the plans, etc., were to be ready for the inspection of bidders by June 1. It is a little doubtful whether this promise can be kept, but the work is being pushed with all possible speed. Chief Constructor Wilson is working with an extra force of draftsmen upon the plans for the hulls, and with the valuable assistance of Naval Constructor Hichborn is making good headway with the detailed specifications. Colonel Remey's office, in addition to its other multifarious duties, is preparing the blank form of proposal and contracts. The plants for the machinery of these vessels are being prepared under the direction of Chief Engineer Melville at Cramp's Works in Philadelphia. Several assistants and draftsmen have been placed at his service and he has been directed to employ all the additional force necessary to give the plans out by June 1. As he only received the instructions last week some lively work will have to be done during the next ten days if the Secretary's wish is to be complied with. The plans of the gunboats, however, will be simply copies of those upon which the machinery of Gunboat No. 1 is being built, and the plans for the 19-knot cruisers will be, practically, duplicates of the *Baltimore's* machinery. The plans of the hulls of the two gunboats by Chief Constructor Wilson are also copies of Gunboat No. 1, now building.

The hulls of the 19-knot cruisers will be similar in design to the *Newark*. The plans and specifications for the hull and machinery of the latter vessel have been practically completed by the Bureau of Construction and Repair and the Bureau of Steam Engineering. The latter bureau is now engaged upon the plans for the machinery of the 6,000-ton armored vessels.

The Board, Captain Ramsay, President, appointed to examine plans for these vessels have agreed upon a report and await notice from the Secretary of the Navy to present it. What they have agreed upon cannot be definitely learned, but it is rumored around the Navy Department that they failed to agree and that the Secretary has declined to receive the report until he can submit certain advice which may force them to arrive at a satisfactory conclusion. It is well known that there was considerable diversity of opinion among members of the Board before they convened the last time, and now that there is so much mystery connected with their report, there would seem to be good reason for suspecting that an unanimous conclusion was not reached.—*Army and Navy Journal.*

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery Avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, JULY, 1887.

A SMALL vessel which shall be capable of high speed and which shall, at the same time, be seaworthy and able to carry a heavy load for her size, is not an easy problem for a shipbuilder to solve. These were the conditions required in the fleet of torpedo boats which have recently been built for the English Government at private ship-yards. At first these boats seemed to be successful, and some of them developed extraordinary speed in smooth water. A trial at sea, however, has resulted less favorably, and in a run of 50 miles, made as nearly as possible under conditions which would appear in active service, one-third—8 out of 24—of the boats broke down, several of them completely and disastrously; two of the failures causing loss of life.

This is hardly a creditable record for the builders, and perhaps for those in charge of the boats. Apart from all structural deficiencies, however, it looks very much as if the torpedo boat as heretofore designed was rather a bad vessel to handle and likely to be almost as dangerous to her owners as to the enemy. At best it is only available for use in smooth water and fair weather.

It is true that torpedoes are depended on for service chiefly in shore and harbor defence, and are not to take much part in sea warfare; but it can hardly be expected that a fleet should be provided for every port on a long coast line, such as that of England or the United States. Torpedo boats cannot well be adapted for long voyages, but should at least be able to transport themselves from point to point along the coast without blowing up or foundering by the way.

IF, as we are often told, the highest civilization will make war a relic of the past by referring all international disputes to a peaceful settlement, we must be still a good way below that highest plane. Just at present it seems as if much of the best engineering talent, both in America and Europe, were engaged in perfecting the means of national attack and defense. The Mechanical Engineers' Society at its Washington meeting devoted a considerable part of its working time to hearing and discussing papers on steel for guns and armor-plate and on national defenses, thus following the example of the Civil Engineers, who occupied several of their monthly meetings during the past season on the same subject.

In one sense such discussions and the wide interest taken in them are not an encouraging symptom, and the time and thought expended might be better employed. On the other hand it may be said that we cannot wait for an ideal state, but must take things as we find them, and from this point of view there is much to be said in favor of the popular feeling that, if other nations are in a position to attack, we must be ready to defend ourselves. This view involves the necessity of providing ships and guns of the most approved patterns, and if we must have these, there should be full discussion of the subject and by the most competent persons. Hence, it is well that our civil and mechanical engineers should bring their experience to the assistance of their naval and military brethren, who will, it is presumed, be ready to accept the help thus offered.

A PAPER presented to the British Institute of Mechanical Engineers on some locomotives built for the Canadian Pacific road drew out a long discussion on the relative merits of American and English locomotives. Some of this discussion was intelligent, but much of it was rather in the line of mere assertion without proof, and disclosed a good deal of the insular prejudice which the English engineer is apt to have against all things foreign. There are plenty of liberal-minded English mechanical engineers who are quite ready to recognize good practice anywhere; but there are also, unfortunately, many who will not admit that anything really good can come from outside their own conntry. This kind of men can be found on this side of the Atlantic also, but they are fewer in number and less prominent than among our British brethren.

Some of the feeling expressed in this particular discussion may have been due to a not altogether unnatural irritation at the fact that Canada, although an English colony, has long ceased to furnish a market for English locomotive builders.

THE Sind-Peshin Railroad, which is a military line on the Afghan frontier of India, runs through a country which, from the descriptions given of it, seems to resemble very much the mountain sections of Colorado and Utah. Its construction involved the solution of engineering problems very similar to those met with in the building of the Denver & Rio Grande and other roads in that territory. The Sind-Peshin line was built by English military engineers, who had entire charge of the work, but one of them, in describing the road, notes that American methods of location and construction proved the most successful and were largely adopted. From the source from which it comes this may be taken as a high compliment to American engineers.

In building this road speed was more an object than cost. It was built entirely for military and political reasons, and there was no question as to whether it would be commercially profitable or not. American methods were adopted, not so much because the road could by them be cheaply built, as because they were better and easier.

It is to be noted that on this line, though it ran through so difficult a mountain country, there was no talk of narrow gauge. The gauge adopted was 5 ft. 6 in., simply because that was the gauge of the connecting line.

A SINGULAR objection to iron sleepers is noted by an English engineer who has had much experience in the building of military lines on the northern frontier of India. The wandering Afghan or Belooch who infests those parts, he says, is a mischievous creature, who is very fond of testing the strength of an iron tie with the biggest boulder he can bring to bear upon it, or with a sledgehammer, if he is able to steal one. On the particular line where these inquiring gentlemen most abound, the ties sent out from England were of cast-iron, and the boulder generally got the best of it, with disastrous results to the track.

THE bill to provide for the safety of travelers, which has been signed by Governor Hill and has become a law, prohibits the use of stoves either inside, or suspended from, a passenger car in the State of New York after May 1 of next year. Stoves now in use may be retained in the cars, but their use is to be permitted only when the cars are standing still, or temporarily in the case of accident or emergency.

Like most laws of this description, the present one seems too sweeping in some of its provisions. That it is possible to make a car-heater or stove which will be safe in almost any contingency, there can be no doubt, and it is possible to frame a law which would permit the use of such a heater and exclude those in which there are elements of danger. If, however, it is admitted that a system of continuous heating by steam or hot-air from the locomotive or a special car is the only plan which is really safe, the new law appears to be defective in allowing stoves to remain in the cars at all. Certainly the use of stoves in standing cars and in case of emergency seems to leave a pretty fair chance for evasion of the law, of which some railroad managers will not be slow to take advantage.

The time allowed before the law takes effect gives railroad managers another winter for trial of the different devices for continuous heating offered to them, and no complaint can be made in this respect. Practically, they have nearly a year and-a-half to prepare themselves, as the law takes effect May 1, 1888, and heating apparatus will not be required for five or six months after that.

THE provision of the law prohibiting the use of car-stoves in New York State, which exempts railroads less than 50 miles in length from the operation of the law, appears to be a serious defect. It seems to have been inserted on the theory that short roads carry but few passengers and are not able to bear the expense of new heating apparatus. But, apart from the consideration which might be urged that passengers on short roads are, at least, as much entitled to protection as those on the longer lines, there are, at least, three or four roads which might be named, and which come under this clause of the law, which carry a large number of suburban passengers to and from New York every day, and on which thousands of lives are yearly exposed to danger. Now, on all of these roads are a number of old cars which are provided with the simplest and most dangerous pattern of cast-iron stoves—heaters which are tolerably certain, in case of any serious accident, to upset and break to pieces, scattering their fire in every direction. Probably the number of passengers carried yearly on these roads exceeds that carried on all the through express trains run by the trunk lines of the State, and it certainly seems as if they were entitled to equal protection.

THE Cleveland *Iron Trade Review* announces that some experiments, which have been conducted for some time by the Cleveland Rolling Mill Company, under the direction of Mr. Eugene H. Cowles, the inventor of the process which led to the production of aluminium bronze, have been very successful in these experiments. Large steel castings, made with steel charged with 0.1 per cent. of aluminium, showed an extraordinary freedom from blowholes and other defects, which are common with ordinary steel castings, and also showed a remarkable increase in tensile strength. Moreover, it was found that the addition of this small percentage of aluminium imparted to the steel the property of making a clean and perfect weld with wrought-iron. The alloy also greatly reduced the chilling of the metal, permitting it to enter the mould readily and to fill it completely, as was shown especially in the casting of a number of gear-wheels.

Should further experience justify the deductions drawn from these experiments, the discovery is an exceedingly important one and will largely increase the uses to which cast-steel may be applied.

THE plans for the Metropolitan or City Railroad in Paris, which have now been under consideration for over two years, have finally been adopted and work will be commenced on the lines as soon as these plans receive the approval of the Legislative Chamber. The general plan includes a system of 36 kilometers in all, a circular line connecting the stations of the different trunk lines entering the city and four transverse lines, crossing nearly at right angles, each of these lines connecting with the circular line at two points in its course. To these, which will constitute the principal system, are to be added two lines, 7 kilometers in all, extending beyond the circular line into the suburbs. Of the entire length of 43 kilometers embraced in the system, about 9¼ kilometers will be elevated railroad, 28 underground, and the remaining 6¼ in a covered subway or cut. All the lines will have two tracks of the standard gauge, and connections will be provided by which trains from the railroads entering the city can be taken at once, without transfer, to any point on the city line. It is not intended that trains shall be so run in ordinary traffic, but this is really a military precaution, taken in order that troops brought from any point may be landed anywhere in the city of Paris where it is desirable to have them.

The elevated line will be a masonry viaduct, which will not follow the line of any streets, but will, as we should say in New York, cut "through the blocks," making its own road and having a lateral street on either side of it. As in the Berlin City Railroad, the arches of the viaduct will be, wherever possible, utilized as store-houses and for similar purposes. Two bridges over the Seine will be required and will be of iron.

The other crossings of the river will be tunnels or sub-

ways, and it is proposed to construct these tunnels of iron tubes, but, the official report says, a special study will be made of these subways and some alterations in the plan, though not in the location of the road, may be required.

There will be altogether on the whole 43 kilometers of line, 68 stations, of which 14 will be on the elevated line, 12 on the covered cutting and 42 on the tunnel line. These stations will be very simple in construction, but will be planned to give abundant space for the large traffic expected. Three of these stations will be for through passengers, where baggage will be received for all the railroads running out of Paris.

The rails to be used will be of the "bull-head" type, and it is probable that iron or steel ties will be used. As the road, when not underground, will be upon a solid viaduct, ballast will be used in the ordinary way.

Paris has never had any system of city steam railroad, having been entirely dependent for city traffic upon the omnibuses, tram-cars, and carriages or hacks. There is a belt railroad running around the city, but it is used entirely for transfer of freight between the railroads and it has little or no passenger business. This belt line, moreover, was not located with a view to serving the city or accomodating passengers, but chiefly to connect the outer line of fortifications built to protect the city against a hostile army. The new City Railroad will be entirely a government affair, and its cost, we believe, is to be paid partly by the General Government and partly by the municipality of Paris.

TECHNICAL education in the lower sense—that of instruction in the actual manipulation of materials and workshop practice—is now strongly advocated and is apparently growing everywhere in popular favor. To a certain extent this is well, but there is some danger that it may be pushed to excess. Practical instruction is necessary, but not to the exclusion of the theoretical, and that is very apt to be the outcome if the present tendency is followed too far. It is not long since that the movement was in the opposite direction, and the theoretical technical education was pursued to the exclusion of the practical, so that the new movement is really part of a natural reaction. It is also a part of the general tendency of our more complicated modern life to divide up and specialize education as much as possible.

The modern workshop school is also an effort to replace the old system of apprenticeship which is now passing away. That it can fully do so is not possible, for no combination of shop and school can teach a boy what he can learn in three or four years of actual shop work. This much can safely be said, however, that a little practice with tools mixed with his book lessons will do a boy no harm and may do him much good, especially if he is not taught to rely on it too much or to consider it a complete outfit for his future trade.

IT is stated that the Abt rack-rail system is to be tried on the English military railroad through Bolan Pass, on the Afghan frontier of India. Materials for 10 miles of road have been sent out, with two locomotives, and the road will be laid this year.

The success of the Abt system on the Harz Railroad has attracted much attention, and this Indian case is only one of several proposed applications of the system.

PERSONS interested in the eccentricities of maintenance of way can see a fine collection of low joints on the Northern Railroad of New Jersey between Sparkill and Nyack. For some three miles each rail forms an arch, the curvature being plainly visible to anyone walking along the track. The rails are of steel, somewhat worn; the joints are the plain fish-plate with four bolts, and are between ties. There are heavy grades over the whole of this section, and the effect on the locomotives of the additional work of climbing over all these little arches may be imagined.

A VERY discouraging view of the condition of the Panama Canal was given to the American Society of Civil Engineers by M. Boulangé, a French engineer recently employed on the canal. His statements corroborate the report recently made by Lieutenant Rodgers, and it was evident, to those who heard him at the Society's meeting, that he spoke with acquaintance of his subject and with full conviction of the correctness of his views. With less than one-quarter of the actual excavation done the company has already spent $180,000,000, part of which was raised at a ruinous discount, and it has now funds on hand for only a few months longer, with very little prospect of raising more. It is true that the enormous sum already spent includes the period of installation, when heavy payments for engineering and plant might be expected; but, on the other hand, some of the most difficult and expensive work has not even been touched, or has barely been begun.

Thus the great Culebra cut has only just been commenced, and the little work done there has developed difficulties altogether unexpected and apparently very difficult to overcome. The damming or diversion of the Chagres River, a work essential to the success of the canal, is so far from execution that no plan for it has yet been settled on, and the engineers agree only in considering it an extremely difficult problem to solve.

The future of the canal is just now exceedingly uncertain, but it does not appear probable that the company will be able to go on much longer with the work. A suspension is to be looked for, though a total abandonment will be postponed as long as possible.

THIS and other accounts of the Panama Canal reveal an almost incredible looseness in the technical administration. That so important a work should be undertaken without sufficient maps and without a really definite final location is sufficiently startling; but when we are told, on apparently good authority, the chiefs of section are required to work without maps, profiles or anything else, in fact, to guide them, it is difficult for engineers to believe that such an administration is possible.

THE American Water-Works Association, which holds its seventh yearly convention at Minneapolis on July 13, is a society whose proceedings should excite much more interest than they usually do. The Association includes a number of engineers of standing, and the general subject of which they treat is one which comes close, not only to the engineering profession, but a large majority of the people. Water supply affects all of us in some degree, and a very large part of our population is now resident in cities and towns where water-works of some kind are

needed. There are many questions, some of them of a difficult nature, to be considered in this convention, and there is abundant room for the exercise of skill and talent by engineers in their solution.

RAILROAD bridges are to be one of the leading subjects for discussion at the Civil Engineers' Convention, the points to be especially treated being the proper inspection of bridges, the strength of floors and the use of safety guards.

In this connection also it is suggested that the discussion include the question of reference of these and similar subjects to committees for consideration and report, and also the question whether it may not be both possible and desirable for the Society to adopt some standards as the Master Car-Builders' Association has done. On this last point there is likely to be much difference of opinion.

TECHNICAL EDUCATION ON THE BALTIMORE & OHIO RAILROAD.

A REPORT, which marks a new departure by the old and conservative Baltimore & Ohio Railroad Company, has recently been issued by Dr. W. T. Barnard, the Assistant to its President. The report is intended to show the economic value of technical education in the development of the industrial arts, and especially in railroad operation.

A person familiar with the ways of the Baltimore & Ohio Company and its officials 25 or 30 years ago, in reading this report, feels somewhat as Rip Van Winkle probably did when he woke up after his long sleep. Whatever may have been the merits of the late Mr. Garrett's management, he certainly did little to encourage the application of science to practical railroad management. The publishing of this report and the creation of a technical school by this company indicates that the present officers have a higher estimation of the value of education than their predecessors had, although the author of the report says that "no one but the writer stands committed to the statements or views therein contained."

A great difficulty in the way of carrying out a scheme like that outlined in the report referred to is that the great mass of workmen do not value or care for education or technical knowledge. That this is the case on the Baltimore & Ohio Railroad is shown by the report, which says:

"When tastes for reading and study are not cultivated in youth, they are seldom acquired in later life by those engaged in manual occupations. In proof of this, I cite the fact that though there is a commodious library and reading room at Mt. Clare, fairly equipped with works of science and industrial mechanics, and where all the important scientific journals are displayed for the especial benefit of our employés, the record shows that, during the past year, out of an average of 3,000 workmen at Mt. Clare, fewer then 50 visited the library at all, and fewer than 15 utilized these journals; thus conclusively showing that they have not sufficient education to appreciate these valuable means of further improvement. Out of 16,120 books circulated during the year, but 1,816 were of a strictly educational character, and they were almost exclusively drawn out by young men and boys attending our class-instruction. A very careful canvass last year, demonstrated the fact that, among this great mass of labor, only one man subscribed to a technical journal, and that man was an ordinary mechanic. A logical deduction from this record is that *our people have little or no knowledge of current improvements, or of the results of scientific investigations of mechanical subjects, and, as a rule, they only know methods crude and generally obsolete elsewhere, and observation confirms this.*"

Again, in a report dated January 30, 1887, Mr. Coler, the principal of the school, says that he and his assistant examined nearly 500 apprentices in the shops of the company and "*that not one of them* was sufficiently advanced to pursue technical studies with profit to the company and to himself. * * * Combined with this lack of elementary knowledge was a corresponding lack of inclination on the part of these apprentices to make of themselves anything more than ordinary routine and rule-of-thumb mechanics." The author of the report concludes "that to try to educate boys who have not formed habits of study before entering upon apprenticeship is a useless waste of time, patience and money."

Of the good effects on the industries of a country or a community of the dissemination of technical education, the report before us contains ample testimony, but that it is essential or important to the great majority of the operatives of a railroad may be doubted. In what way would a knowledge of algebra improve a man's efficiency, who is employed in turning car-axles from one year's end to another? It is doubtful whether a knowledge of the chemistry of combustion will make a fireman more efficient than he would be without. Perhaps thermo-dynamics might help a locomotive runner to save fuel, but it is very doubtful. A blacksmith's helper or a boiler-maker would not be any more efficient, in their respective occupations, if they understood the principles of statics and dynamics than if they do not. In the very nature of things, many men must be constantly employed on a railroad to turn axles, to fire and run locomotives, make boilers and forgings, and similar occupations for which manual skill, industry, endurance, and faithfulness in the performance of duty are the essential qualifications.

It is in the management of the different departments of a railroad that scientific knowledge has its chief value. The old dispute about the relative value of practical and theoretical knowledge will not be taken up here, as anyone with experience knows the two should be combined. But if technical knowledge is to have any value in the management of railroads, those who have that knowledge must have adequate authority. Now, on the Baltimore & Ohio Railroad we have the curious anomaly that the authority of the heads of the engineering departments is made subordinate to that of the Purchasing Agent. It may fairly be presumed that the Superintendent of Machinery and Chief Engineer of a great road, which has organized a school, on a liberal scale, for the education of its employés, would be men of adequate practical and scientific training to qualify them for the responsibilities of the positions they hold.

Such training will be of very little use unless those who have it also have the requisite authority to manage the road. Few men with the knowledge which the head of any of the principal departments of a road like the Baltimore & Ohio Railroad should have, would be willing to have his authority over the department for which he is held responsible made subordinate to that of a person whose chief duty and only qualification is that of driving a sharp bargain with those who sell what the company must buy. Therefore, the educational scheme and the distribution of authority on the Baltimore & Ohio Railroad are antagonistic to each other. This company will

be obliged either to stop educating its employés or to suppress its Purchasing Agent, because men of any considerable degree of scientific knowledge and practical experience would have careers open to them in which they would not be made subordinate to a person whose chief distinction is that he excels a Bowery clothing dealer in driving sharp bargains.

Of late years it has been almost impossible for any one, no matter how extensive his knowledge or experience concerning the mechanism, engineering or operation of railroads might be, to communicate with the Baltimore & Ohio officials excepting through the Purchasing Department.

The head of that department is judge, jury and expert in matters of which he is profoundly ignorant, in which he will hear no argument, and from his decisions there is no appeal. He treats many who have business with the company with so much insolence that those who have sufficient independence refuse to have any dealings with him. Some of the largest manufacturing establishments refuse to bid on work, the orders for which must come through his hands, and his name is execrated from one end of the land to the other by those who have had to come in contact with him. If the Baltimore & Ohio Railroad Company determines to continue its educational scheme, one of the first things to do should be to establish a department for instruction in the amenities of business intercourse and compel its Purchasing Agent to spend half a century or so in that kind of study.

There is great room for doubting whether it is any part of the duty or function of a railroad company to undertake the education of its employés, excepting in matters pertaining directly to the main purpose for which a railroad company is created, which is to carry freight and passengers. It obviously should teach its locomotive runners how to manage their engines and operate the brakes, because that kind of information is not taught in the schools. It is important, too, that its workmen should understand drawings, and unfortunately drawing is not taught in the schools as generally as it should be, and therefore workmen must learn it elsewhere. As mechanical drawing can be taught best in connection with a workshop, it is always well to give men a chance to learn how to draw the objects with which they are familiar. Instruction in other branches which have a special application to their occupations may be desirable, but nearly every State, city and town now gives ample facilities for getting even more than what is called a common-school education. A railroad company may with advantage supplement the common schools, and teach specialties relating to the work of its employés, but it is very doubtful whether it can or should assume to do what the schools are created for. If it aims to give a thorough course of technological instruction it will probably fail, as railroad officers rarely have the qualifications required for conducting a school of science.

If instead of attempting to educate its own men the Baltimore & Ohio Company would make its service attractive to those who have been educated elsewhere, it would be likely to attain what it is aiming at sooner than it will through the technical school which it has organized with commendable liberality. The first thing to do to make its service attractive, is to cut the wings of its Purchasing Agent, who now soars so arrogantly over all who are unfortunate enough to be obliged to have any dealings with him. Instead of attempting to educate men, that company would do much better to find those who have received their theoretical education elsewhere and give them a chance to get their practical experience in the service of the Company. The Pennsylvania Railroad adopted this plan years ago, and the results are known the world over.

THE POUGHKEEPSIE BRIDGE.

WORK on the great bridge over the Hudson River at Poughkeepsie is in such a condition that its completion is now, apparently, reasonably sure, after years of effort on the part of its projectors and of continually recurring disappointment. At first the apparent success of the Poughkeepsie Bridge had the effect of stimulating the rival projects for bridges over the river, and the advocates of the proposed bridge at Storm King and the suspension bridge at Anthony's Nose, near Peekskill, were active in urging the advantages of their plans. Lately, however, nothing has been heard of them, and the bridge at Poughkeepsie seems likely to be, for some time at least, the only bridge crossing in the 150 miles between Albany and New York.

The Hudson is the last of the great rivers of the United States to be bridged. The Mississippi, the Missouri and the Ohio have been crossed at many points in the West, and the Delaware and Susquehanna in the East are spanned, but the Hudson has remained clear of bridge crossings through nearly all its navigable length. There have been projects enough for many years back, and they have had plenty of advocates, but the Poughkeepsie Bridge is the only one that has ever reached the stage of actual construction. This is not so much the result of physical obstacles, for there are several points at which bridges are entirely practicable without serious obstruction to navigation, in the light of late experience with long spans, and hardly anywhere along the river would such difficulties be encountered in building the substructure as have been overcome at several of the bridges over the Missouri and the Mississippi. The Hudson is broad and deep, and is, in fact, more a tidal estuary than a river; but the high, rocky banks which mark much of its course, and the rock bottom which can be found at most points at a moderate depth present conditions favorable to the engineer. It carries an immense traffic, and a very large part of it is in the form of long tows of barges and canal boats which require room for their handling; but these can be provided for by spans which do not exceed in length some which were successfully erected years ago. The river boatmen have actively opposed the building of the bridge now under construction, but it does not appear that any greater difficulties will be found in passing the largest tows between its piers than are now experienced in handling them in the narrow channels between Albany and Catskill. There are also the advantages that the river is comparatively free from such strong and dangerous currents as affect the navigation of the Mississippi or the Missouri, and that its channel is stable and unchanging.

The real causes for the delay in bridging the Hudson have been the absence of such a pressing necessity for a crossing as has existed elsewhere, and a general doubt as to whether a costly bridge would pay. The larger part of the rail traffic from the West to New England has for many years taken the route through Albany, and canal

traffic which was bound for that section of course requires no bridge, as the transfer from boat to car can be made as readily on the eastern as on the western bank. Such freight business from the South as goes to New England points by rail is transferred at New York, where a bridge is entirely out of the question, and would not be likely to take a circuitous route to avoid the ferry transfer. There is not, anywhere along the river, a local traffic which would pay for the building of a costly structure.

The only traffic which could be relied on to support a bridge, without a diversion of business from older routes which it would take a long time to effect, is in coal, iron and similar freights from Pennsylvania. New England is not to any extent a fuel-producing region, and, aside from the wood which is used in the country districts for household purposes, its supplies of fuel for both manufacturing and domestic purposes are procured from the mines of Pennsylvania. The coast towns and cities have always received their supplies by water, and this business is now so organized that no rail route can possibly carry it more cheaply. There is, however, a large section of the interior to which coal is now carried by rail from the ports on Long Island Sound and the Atlantic Coast, and this section could probably be as well, perhaps better, served by the bridge route. It is mainly on this traffic that the bridge must rely for support until a share of Western business can be diverted from the Northern rail and water routes to the Erie and the Pennsylvania lines. A serious doubt as to whether the traffic over the bridge would be sufficient to pay interest on its cost is the chief reason why it has not been built before.

At present, it seems probable that the bridge will, with proper connections, be a success commercially as well as from the engineering point of view. The building of two or three rival bridges would certainly result in the financial failure of all of them, but a single bridge ought to be able to maintain itself, though it can hardly fulfill the high expectations which some of its projectors seem to entertain of the profits of the enterprise.

The Poughkeepsie Bridge has its rail connections practically still to be made. The single line from the bridge eastward is not now in a condition to do a large business. A short railroad line connecting with the New York & New England Railroad is to be built, and is a necessity. On the western side of the river a line, not very long, but through a hilly and difficult country, must be built to enable any railroad to reach the bridge. At present there is nothing at that end. Not very much new railroad beyond this, but a considerable adjustment and rearrangement of connecting lines will be necessary to secure the desired business.

The plans and construction of the bridge will doubtless furnish interesting topics of discussion to the large number of engineers who will visit it during the American Society's convention early in the present month.

NEW PUBLICATIONS.

REPORT OF THE SECOND ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS: 1887. Champaign, Ill.: published by the Society, Professor A. N. Talbot, Secretary.

THIS report, besides the annual statements of the officers, contains the annual address delivered by the President, Professor I. O. Baker, on the progress of Engineering during the year, and a number of papers read by members. The distinguishing feature of nearly all these papers is their practical nature and directness of application. The subjects treated of include Drainage for Cities; Surveys for Drainage Purposes; Township Boundaries; Perpetuation of Corners; Reservoirs for Mills and Farm Use; Pavements for Small Cities, and others of a similar nature.

Besides a report on general engineering progress, committee reports are presented on Land Drainage and Public Highways; Instruments, Blanks and Records; Sanitary Engineering and Water Supply and on Mining Engineering. Some of these reports are of value; others are hardly up to the standard which might be expected. Something is to be excused, however, to engineers whose time is usually so fully occupied.

BOOKS RECEIVED.

GAS POWER COMPARED WITH STEAM POWER. By JOSEPH EMERSON DOWSON. London: Published by the Institution of Civil Engineers.

RECENT RESEARCHES IN FRICTION, BY JOHN GOODMAN. London: Published by the Institution of Civil Engineers.

PRESSSURE-RECORDING INSTRUMENTS. BY JARVIS B. EDSON, M. E., New York. This is a reprint of a paper read by Mr. Edson before the United States Naval Institute at Annapolis, at the meeting of March 4, last.

AMERICAN INSTITUTE OF ARCHITECTS; PROCEEDINGS OF THE NINETEENTH ANNUAL CONVENTION. Newport, R. I.: GEORGE C. MASON, Jr., Editor and Secretary of the Institute.

ROYAL ENGINEERS' INSTITUTE, OCCASIONAL PAPERS, VOLUME XI. Chatham, England: Edited by Captain FRANCIS J. DAY, R. E., and published by the Institute. This volume contains several papers of much interest, notably those on Frontier Railroads in India, and on Road-making in Western India.

THE ECONOMIC THEORY OF THE LOCATION OF RAILWAYS: BY ARTHUR MELLEN WELLINGTON. New York: John Wiley & Sons and *Engineering News*. This is a revised and very much enlarged edition of the book with the same title which was published by Mr. Wellington some years ago, and which was much appreciated by engineers. We hope to review the new edition at length hereafter.

THE MOLTENS RESERVOIR: BY CHARLES JOHN WOOD. London; published by the Institution of Civil Engineers.

DREDGING OPERATIONS AND APPLIANCES: BY JOHN JAMES WEBSTER. London; published by the Institution of Civil Engineers. This book includes an abstract of a discussion on the subject, as well as Mr. Webster's paper.

THE OFFICIAL RAILWAY EQUIPMENT GUIDE: Cleveland, Ohio. This is the new name adopted by the publication formerly known as *Sechrist's Hand-Book and Railway Equipment and Mileage Guide*. The new title is certainly more convenient aud less cumbrous than the old one. The *Guide* is an exceedingly useful publication, and must be indispensable to railroad offices.

PROCEEDINGS OF THE ENGINEERS' CLUB OF PHILADELPHIA: VOLUME VI, NO. 2. Philadelphia; issued by the Club. As usual with this Club, the present number of the *Proceedings* contains several papers of value.

REVISTA MENSAL ENGENHARIA E INDUSTRIA: CLUB DE ENGENHARIA, RIO DE JANEIRO, BRAZIL. This is a new monthly publication, issued by the Engineers' Club of Rio de Janeiro, Brazil. It contains the proceedings of the Club and papers presented by the members.

THE TANITE COMPANY'S ILLUSTRATED CATALOGUE OF EMERY WHEELS AND GRINDING MACHINERY. Stroudsburg, Pa.; issued by the Company.

ELECTRIC LIGHT PRIMER; BY CHARLES L. LEVEY. New York; published by the author. This is a brief description of the electric lights chiefly used, with definitions of electrical terms.

JOHNSON STEEL STREET RAIL COMPANY; GIRDER RAILS AND PERMANENT WAY FOR STREET RAILROADS, Johnstown, Pa.

IMPROVED CORLISS ENGINES; BOILERS, SHAFTING AND GEARING; ROBERT WETHERILL & CO. Chester, Pa.

CATALOGUE OF RAILROAD SUPPLIES; CRERAR, ADAMS & COMPANY, Chicago, 1887. This catalogue is probably one of the largest and most nearly complete of its kind ever issued.

CINCINNATI CORRUGATING COMPANY: CATALOGUE. Cincinnati, 1887. This is a catalogue of roofing and building material of corrugated and other sheet metal manufactured by the company.

OBITUARY.

MR. GILMAN TRAFTON died at his residence in Louisville, Ky., May 25. He was for many years Engineer of the Louisville Bridge & Iron Company, but resigned that position a few months ago on account of ill health. He was well known as a bridge engineer and had designed many important works. He had been a member of the American Society of Civil Engineers since 1871.

MR. WILLIAM JACOMB, who died suddenly in London, England, May 25, was a pupil of the late Mr. Brunel and afterward assisted him in several of his works. He had immediate charge of the building of the famous steamship *Great Eastern*. Later he confined himself to railroad work, and for several years past had been Chief Engineer of the London & Southwestern Railway.

SAMUEL GATY, who died in St. Louis, June 9, aged 76 years, made the first casting ever turned out from a St. Louis foundry, built the first engine made west of the Mississippi River, and aided in the construction of the first steamboat, the *Eagle*, accredited to St. Louis builders. He was born in Kentucky and served his time at a foundry in Louisville. In 1828, he went to St. Louis and established the first foundry there, afterward adding a machine shop. In 1862, he retired from that business, but was for a time President of the Ohio & Mississippi, Western Division. He was also interested in other railroads and in mining property.

Contributions.

Rail Sections.

AN esteemed correspondent writes: "I may state that the result of my observations would, I suppose, class me with those who advocate small radii for throat of wheel and upper rail corner. I may venture the opinion that excessive wheel loads also contribute largely to the side-wear of rail and flange. I mean, that when the true curves are found, the wear will still go on.

"As railroads are now organized into departments, the upper corner of the rail forms the boundary between the car and the roadway departments, each managed on an independent basis. If the settlement of the question were assigned to either department, I believe that a satisfactory solution would soon be reached."

To the Editor of the Railroad and Engineering Journal:

REFERRING to the article in your May number regarding rail sections, I could give you diagrams of standard sections on the Atchison, Topeka & Santa Fé Railroad, diagrams and tables of rail-wear and diagrams of wheel-wear, but I refrain from thus occupying your space for, if I comprehend the situation at all, the main question is not what is the best theoretical section either for strength or least wear. We have many good (claimed to be superior) sections in use on our trunk lines, any one of which will do for a train to run over. In my opinion the section to be adopted should be decided upon in the same way as the standard car-wheel tread or section was decided upon, by a majority vote of all interested parties.

The shape of the head is probably all that needs to be standard. The important result is not so much to find a section that will be theoretically a perfect one. Neither is it necessary to get the one that will best suit the majority of roads. The best rail to adopt is the one in common use, which will best *preserve the gauge* in connection with the standard wheel.

The fact that some rail-heads have outward sloping sides, others inward—some 3/8 in. radius on upper corners —others 5/8 in.—and the fact that some roads gauge near top of head (the correct gauging point) while others gauge at the bottom of the head, are the causes for the present variation in widths of the *standard* track gauge of at least 3/4 in. in tight gauge, and fully twice that on curves where some roads allow 1 in. (or more) wider gauge, while others keep tight gauge.

The 1 3/8 in. variation in rolling-stock gauges and 1 3/4 in. variation in track gauges are the cause of a large amount of wear and tear on track and rolling-stock, to overcome which should be the first aim in adopting a standard section.

The wheel section already adopted should be consulted and allowable limits of variation should be established.

With the present variations in gauges it is absurd to call our gauge of standard roads 4 ft. 8 1/2 in. We might as well say 4 ft. 8 in. or 4 ft. 9 in.

If we can pick out six of the most common sections we can well afford to take the poorest of the six as a standard rather than to fool away more *expense* in delay.

If we can adopt a rail section *and a gauge* with not more than 3/8 in. total difference between wheel gauge and track gauge, keeping our gauge standard on curves as well as tangents, letting each road narrow its engine-driver tires to suit its own curves, we shall save hundreds of thousands of dollars per annum in repairs of track and rolling-stock, and all of it will not be saved on rails and wheels. My point is simply this: Give us any of the best sections in use, but let the matter of gauging be brought to as fine a point as possible.

H. V. HINCKLEY.

THE GEODETIC WORK IN THE UNITED STATES.

V. THE U. S. COAST AND GEODETIC SURVEY.—CONTINUED.

BY PROF. J. HOWARD GORE.

THE unsettled condition of the political affairs of the country about this time, prevented any further consideration of the Survey project until March, 1811, when Mr. Gallatin requested a friend to ascertain if Mr. Hassler would undertake the mission to London for the instruments. An affirmative answer was at once given, and preparations for the trip begun in the way of making drawings and consulting those in authority regarding the details. On August 25, Mr. Hassler sailed for Liverpool, and the day after his arrival in London, he had a conference with Troughton and other makers. The superior workmanship of Troughton commended itself so highly that he was selected to make the major part of the instruments wanted. This, together with the fact that he was at that time working on the great mural circle at Greenwich, explains the delay to which Hassler was subjected, and for which he has been so frequently and so unjustly censured. This is further shown by a letter received from the Treasury Department in June, of the year following, instructing him to remain in London until the completion of his mission, political charges notwithstanding. A visit to Paris was made to procure books and standards which cost considerable time, the rebellion then in progress making it difficult and very tedious to procure passports. Also the construction of instruments from original design, requiring in some cases the manufacture of the needed patterns and tools, was a more protracted task than was contemplated, so that it was not until December 14, 1815, that the instruments were unpacked and placed in the University of Philadelphia, under the care of Robert Patterson, duly delivered as the completion of the mission.

The plan for putting into operation the survey of the coast was submitted to Mr. Dallas, then Secretary of the Treasury, January 5, 1816, and the approbation was received in return a couple of weeks later. It was not until May, however, that Congress made the requisite appropriation, while the commission as Superintendent was not signed until August 3 of that year. This document was taken from Hassler's scheme previously submitted. It specified, by way of instruction, that the assistants were to be derived from the Corps of Engineers and from the Navy, that the traveling expenses were to be paid by the Government, except in the case of the Superintendent, whose salary of $5,000 a year was to cover his expenses, and that draftsmen were to be employed as their services were needed. Even before his appointment as Superintendent. Hassler had spent several weeks seeking a suitable place for the measurement of a base line, visiting for this purpose, then and later, portions of the New Jersey and Long Island coasts, Hempstead Plains and various places along the Hudson River. The first report, transmitted November 23, 1816, gives a detailed account of this search. The difficulties experienced from wooded marshes and lack of sharp points near the coast impressed him more than ever with the necessity of carrying along a strong chain of triangles back from the shore, with secondary triangles to check the off-shore and in-shore work. During the following spring the reconnoitering was prosecuted vigorously, meeting with success in the way of a suitable site for a base in the valley of the English Neighborhood and Tinively, at the west foot of the North Mountains. Two preliminary measurements of the line were made with a chain constructed for the purpose giving 9,446 meters as the mean, the two results differing very slightly from one another. The more accurate determination was deferred, the time being wanted for the re-erection of signals and the adjustment of instruments. The signals were cones made of sheet tin, about 16 in. high, diameter of the lower base the same, while that of the upper base was 14 in. They proved to answer very well in a morning or evening illumination, in one case being visible from a point somewhat more than 30 miles distant.

As had been expected, the instruments were in great need of adjustment after a space of five years, in which time they had made a long journey over land and water confined in boxes and under unequal pressure and strain of their different parts. It was found that the smaller theodolites had fared better than the larger ones, giving to the latter only the advantage of better seeing with their more powerful telescopes. The following extract from a report of progress written this year shows the accuracy thus early obtained. "The results of my observations have proved very satisfactory in point of accuracy; as far as the preliminary computations have led hitherto the sum of those angles of a triangle, of which all three angles are measured, being within about one second in a mean equal to two right angles; and the distances concluded by various elements agreeing in a mean within 1 ft. in distances from 8 to 20 miles. So that every desirable accuracy is likely to be obtained by the proper combination and reduction of the observations and their accurate calculation, which must be the work of this winter; and the results will, I hope, enable me to begin next summer the detailed survey."

A second, or verification base, was measured in December, 1817, upon the sea shore of Long Island, near the Narrows. The length of this line was found to be 7,753 meters. The results of three different combinations of the triangles carried out upon it, falling all within two-tenths of a meter, were taken as confirmatory of the accuracy of the original base.

As was quite natural, the beginning of a work so vast, in a country almost in its native condition, without trained assistants and with instruments needing trial and adjustment, was a tedious and slow process, so much so in fact that the Secretary of the Treasury wrote to the Superintendent: "For it must not be dissembled that the little progress hitherto made in the work has caused general dissatisfaction in Congress, which, if not removed may lead to a repeal of the law under which you are now acting." In answer to this letter, Hassler gave a detailed account of his operations up to that time, stating how he himself had been up and observing with or before sunrise, that he had worked upon the preliminary computation till late at night; that he had formed 80 triangles, embracing 41 stations, at each one of which he had measured every angle; that two bases had been measured; and that a sufficient number of latitudes and azimuths had been determined to place the work in its proper place on the earth, and give to it its proper direction. These were the results of four months' actual work which caused the dissatisfaction of Congress.

Perhaps, if we could only look deeper, we might find that, while the Secretary of the Treasury has been made to carry the blame, others were instrumental in the passage of the act repealing all former acts relating to the appointment of a civilian superintendent and placing the Survey under the direction of the War Department. We might see in the number of engineer officers left without duty by the peace of 1815 a dissatisfaction with service under a foreigner, and a hope that if the entire work were under their control, it might be so apportioned as to give to each some professional service. This law of 1818 authorized the employment of none but Army and Navy officers for field work. Under the new *regime* some detached surveys were made, but the work lacked harmony, and being executed by different persons and with various methods, it was impossible to unify the results. As a whole, the year's operations were unsatisfactory, and, acting upon the principle that silence would render the shortcomings less conspicuous, the Department under whose direction it was placed, did not, in its annual report, make mention of its rise, growth or decay.

Parenthetically, it may be remarked that, after his summary dismissal, Hassler was employed as Astronomer, on the part of the United States, to the Commission for fixing the boundary, according to the fifth article of the Treaty of Ghent, between the United States and Canada. While acting in this capacity, the English astronomers were so put to shame on account of the inferiority of their instruments that they sent home for better ones, and when received they did not equal those Hassler had designed 10 years before.

From 1819 till 1832 attempts were made from time to time to make a survey of portions of the coast under the direction of the Navy Department; there were also made some surveys of rivers and harbors, together with hydrographic examinations of the coast of a few of the States, but being isolated and without checks or verification they reflected no credit upon the Navy or the country. The desultory work and questionable results caused the Committee on Naval Affairs in 1828 to make inquiry of the Secretary, Mr. Southard, requesting his opinion regarding the character of the operations and the reliability of the charts. He replied that the charts were expensive and unsafe, and recommended a recurrence to the law of 1807. Fortunately, Hassler's presence in Washington about this time, examining and comparing the standard weights and measures in accordance with the act of May, 1830, gave him a better opportunity to explain to those in authority what had been done, what remained to be done and the best way of doing it, so that the law of 1832, reëstablishing the Coast Survey, removed the restriction regarding the sole employment of officers of the Army and Navy, and in August of the same year Hassler was appointed Superintendent. Work was begun in September with the aid of two assistants, but owing to the lateness of the season, operations were limited to the re-erection of signals at the stations used in 1817. In the following year a larger party was put in the field, some to carry on secondary triangulation, others to do detail surveying and sketching while the reconnoissance was pushed in both directions along the coast. The *personnel* of the Survey continued to increase, so that at the end of 10 years there were employed 27 civil assistants and 18 officers of the Navy, with four vessels for off-shore work. In 1834, the Fire Island base was measured with an apparatus of Hassler's own devising; the length was 14,058.9 meters. The principal triangulation was carried from Point Judith to below Philadelphia, in the Delaware, and the secondary, commencing at the same point on the north, covering the sea coast as well as the shores of Long Island and the Delaware, was carried as far south as Capes Henlopen and May, and to Annapolis in the Chesapeake. A reconnoissance had been made in North Carolina, and the site of a base selected from which similar operations should emanate. Four sheets of the large map of New York Bay and harbor were finished, and the reduced sheets of the bay and Long Island were ready for the engraver, together with the whole of Delaware Bay. The soundings of the outer coast had been carried far enough seaward for all practical purposes of navigation. In the whole work the triangulation covered 9,000 square miles, furnishing determinations of nearly 1,200 stations for the representation of 1,600 miles of shore line; 168 topographical maps had been made and 142 hydrographic charts filled up.

The entire cost up to this time, from the beginning, was $881,549, besides about $287,000 for equipments of the naval parties engaged in soundings.

Although the progress so far made was very great, and the expense comparatively slight, the pressing demands of the growing commerce of the country caused many complaints to be heard in Congress against the administration of the Survey, with the text that the slow advance in the work was due to refinements altogether unnecessary for the ultimate purposes of the Survey, and that the practical tangible results were inadequate to the expenditure. With the plea of extravagance, it is easy to attract, if not secure, the attention of Congress, so in the present instance the cries were listened to, and the causes of the clamors were investigated in 1842 by a congressional committee. The scrutiny to which the work was subjected was of an unfriendly character, and the examination was addressed rather to the Superintendent than to the operations under his direction. The result was a complete vindication of the methods then in use.

A proviso was attached to the appropriation bill of 1843, directing that the Survey be thereafter prosecuted in accordance with a plan of reörganization to be prepared by a board of officers, consisting of the Superintendent, two first assistants, two naval officers in charge of hydrographic parties and four officers of the corps of engineers. This board convened on March 20, 1843, and in their plan then adopted they set their seal of approval upon the methods already employed, and reared to Hassler his greatest monument by taking the original scheme as the basis of reörganization and the guide to be followed in the further execution of the Survey.

The worry of this examination, the continuous trouble with the auditing officials and the numerous and severe exposures to which, in his enthusiasm, he subjected himself, so affected his physical nature that death came to his relief in November, 1843.

A Large Lake Steamer.

THE new steamer *Aurora*, now nearly completed at Cleveland, O., for the grain and ore trade on the upper lakes, is an excellent example of the large carriers now used in that trade. Her capacity is 3,000 tons of freight, and she is expected to make 14 miles an hour under steam. The *Aurora* is owned by Captain Wm.

Mack, Mr. John Corrigan and others, and has been built under the supervision of Captain Mack.

The *Aurora's* length of keel is 293 ft., and she is 312 ft. over all. The breadth of beam is 42 ft. outside everything. The molded depth in the shoalest place is 24 ft. 6 in.; shear, 6 ft., the after depth being 30 ft. 6 in.

The frames are 6-in. flitch, double, with extra long floors, from bilge to bilge without a break, 19 in. at the seat and 17 in. at bilge, 9 in. at top height. The keel is 9 × 16 in.; main keelson, 16 × 16 in.; sister keelsons, 16 × 16 in.; 12 floor keelsons, 6 on each side, 15 × 16 in., bolted through every frame with five 1-in. bolts; the frames are 21-in. centers. The keelsons are bolted through into keel with 1¼, and garboard with 1¼-in. bolts; the rider keelsons are 17 × 18 in., bolted clear through with 1¼-in. iron. Garboard is 8 in., next 7, and bottom all 6 in. white-oak. Top sides are 5 in., except three strakes of 7 in. let into frames. The ceiling is all 6 in. from last big keelson. There are five strakes commencing with 11 in. and diminishing to 6 in. at ceiling, going up 6 in. to main deck, then 7 strakes 7 in. thick are notched into frames 1 in., all edge-bolted, 2 bolts between frames, with 1-in. iron shelf-pieces under main deck, 6 in. × 3 ft., bolted through inside of vessel; upper shelf under spar deck the same. The deck is of 3-in. white pine. There are 8 hatches to handle cargo. There are four masts, with standing gaffs to handle cargo; no sails.

There will be three steel arches, two on the outside, the lower arch catching hold of the extreme corner forward and going up high amidships, then ending at the extreme lower corner aft. This arch is of steel, 1 in. thick and 12 in. wide; the length is 310 ft. The next is 10 ft. above the first, and is of the same size. A steel cord catches the stem on one side and goes around the vessel without a break to the stem again on the other side; this steel cord is 1 × 12 in. and is 635 ft. long. The other arch is on the inside, abreast of the first one, and is put in so that bolts (1⅛ in.) go through outside plank, outside arch, frames, ceiling inside and through this inside arch, thus fastening by riveting together the whole mass; there are 4 bolts in every frame, through and through. All fastening is the best 1-in. iron. Batten planks are bolted on with 4 bolts and 2 spikes in every frame, and top sides with 2 bolts and 2 spikes in every one. The top strake is 7½ and 8 in.

There are 1,300,000 ft. of lumber and 350 tons of iron used in the construction of this vessel. Her model combines great displacement with fine ends.

For handling cargo the ship has Emerson steam winches forward, capstan and steam capstan aft. She is provided with Williamson Brothers' best steering gear.

The boilers are on the main deck. The cabins are aft the boilers and forward of foremast.

The engines of the *Aurora* are of the triple-expansion type with latest improvements, and were illustrated in the June number of the JOURNAL, pages 253 and 254. The engines are built by the Cleveland Shipbuilding Company, and the hull by Murphy & Miller, of Cleveland, Ohio.

LOCOMOTIVE FOR THE ANTOFOGASTA RAILROAD OF CHILI.

THE accompanying illustration represents a locomotive of 30-in. gauge built for the Antofogasta Railroad of Chili by the Baldwin Locomotive Works in Philadelphia. The dimensions of the engine are as follows:

WEIGHT AND GENERAL DIMENSIONS.

Gauge of road	2 ft. 6 in.
Total weight of locomotive in working order	51,880 lbs.
Total weight on driving-wheels	36,190 lbs.
Total wheel-base of locomotive	20 ft. 9 in.
Distance between centers of driving-wheels	5 ft. 8 in.
Distance from center of cylinders to center of main drivers	9 ft. 5 in.
Length of main connecting-rod between centers	5 ft. 1 in.
Transverse distance between centers of cylinders	6 ft. 1 in.

CYLINDERS, VALVES, ETC.

Diameter of cylinder and stroke of piston	13 × 20 in.
Horizontal thickness of piston over piston-head and follower-plate	4¾ in.
Kind of piston packing	Steam
Diameter of piston-rod	2¼ in.
Size of steam ports	12 × 1 in.
Size of exhaust ports	12 × 2 in.
Greatest travel of slide-valves	4¼ in.
Outside lap of slide-valves	1/16 in.
Inside lap of slide-valves	1/32 in.
Lead of slide-valve in full stroke	1/16 in.
Throw of upper end of reverse lever	3 ft. 1 in.
Sectional area of opening in each steam pipe	12.5 sq. in.

WHEELS, ETC.

Diameter of driving-wheels outside of tires	48 in.
Diameter of truck wheels	26 in.
Size of driving-axle journals, diameter and length	6 × 7 in.
Size of truck-axle journals	4 × 6 in.
Size of main crank-pin journals	3½ × 3½ in.
Size of coupling-rod journals	3 × 3 in.
Length of driving-springs, center to center of hangers	2 ft. 8 in.

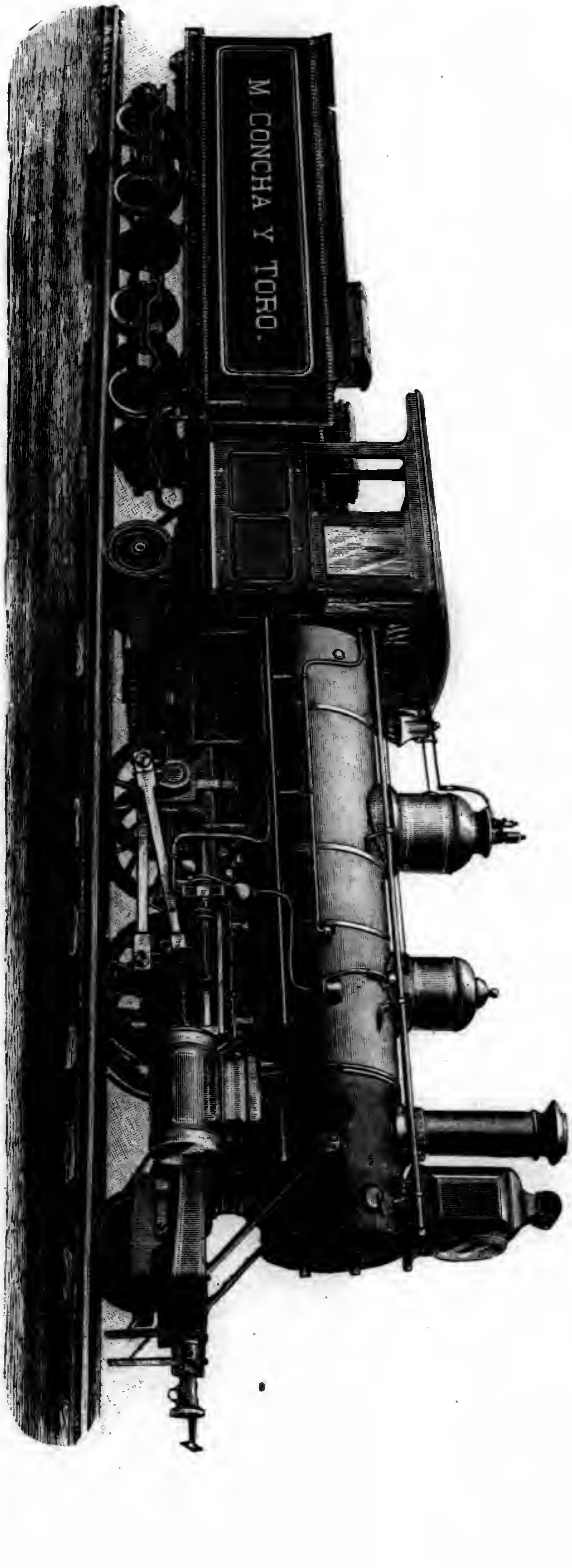
BOILER.

Description of boiler	Straight top, 1 dome.
Inside diameter of smallest boiler ring	42 in.
Material of barrel of boiler	Steel.
Thickness of plates in barrel of boiler	⅜ in.
Kind of horizontal seams	Lap seams, double riveted.
Kind of circumferential seams	Lap seams, single riveted.
Material of tubes	Brass.
Number of tubes	109.
Diameter of tubes, outside	2 in.
Distance between centers of tubes	2⅝ in.
Length of tubes over tube-plate	10 ft. 6 in.
Length of fire box, inside	50 in.
Width of fire-box, inside	32 in.
Depth of fire-box from under side of crown-plate to bottom of mud ring	57 in. front. 56 in. back.
Water spaces, sides, back and front of fire-box	2½ × 2½ × 3½ in.
Material of outside shell of fire-box	Steel.
Thickness of plates of outside shell of fire-box	⅜ in.
Material of inside of fire-box	Copper.
Thickness of plates in sides, back end and crown of fire-box	½×½×½ in.
Material of fire-box tube-plate	Copper.
Material of smoke-box tube-plate	Steel.
Thickness of front and back tube-plates	½ × ½ & ¾ in.
Crown-plate is stayed with	Rad. stays.
Diameter and height of dome	24 × 21 in.
Working steam-pressure per square inch	130 lbs.
Kind of grate	Plain cast-iron.
Width of bars	¾ in.
Width of openings between bars	¾ in.
Grate surface	11 sq. ft.
Heating surface in fire-box	69 sq. ft.
Heating surface of the outside of tubes	594 sq. ft.
Total heating surface	663 sq. ft.
Kind of blast-nozzle	Double.
Diameter of blast-nozzles (three sizes furnished)	2 × 2¼ & 2½ in.
Smallest inside diameter of smoke-stack	13 in.
Height from top of rails to top of smoke-stack	13 ft.
Smoke-box	Straight.

TENDER.

Weight of tender empty (actual)	25,000 lbs.
Weight of tender with fuel and water	40,000 lbs.
Number of wheels under tender	8.
Water capacity of tank (in gallons of 231 cubic in.)	2,400 gals.
Coal capacity of tender or fuel bin	4 tons (of 2,240 lbs).

In the construction of this engine the problem presented was to build an engine of the exceedingly narrow



LOCOMOTIVE FOR THE ANTOFOGASTA RAILROAD OF CHILI.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

gauge of 30 in., having a weight of about 25 net tons, driving-wheels 48 in. diameter, and sufficient lateral stability to run at a speed of 30 to 45 miles an hour. To meet these requirements the placing of the frames outside of the driving-wheels was resorted to, a practice by no means new, but one which has so long been abandoned that its revival may be considered a novelty. The equalization is between the leading truck and the leading driving-wheels and between the trailing truck and the trailing driving-wheels. The system of equalization employed is sufficiently indicated by the photograph. The forward truck is made side-bearing to contribute to the steadiness of the engine and prevent its riding on the equalizing fulcrums as on a knife-edge. The result of this construction is that the engine is perfectly steady laterally. The distance from center to center of frames is 43 in., and the distance from center to center of springs affords a lateral, flexible base almost as great as that of a standard-gauge locomotive. This construction also admits of the maximum width of fire-box, 32 in., which compares favorably with standard-gauge practice.

THE RESISTANCE OF TRAINS.

[From the report of the Brake Committee of the Master Car-Builders' Association on the Burlington tests.]

THE following figures give briefly the results of the No. 7 special tests made to determine the frictional resistances of the various trains. The trains were composed of 49 or 50 empty cars with dynamometer and way-car, and American type engine and tender. The track and rails were in good condition and the wind light.

Each train was tried once on a slightly descending tangent, and once on a curve, situated on an average descending grade of 50.6 ft. per mile. The resistance was ascertained on the tangent by running up to stop-post No. 1 at about 20 miles per hour, and then shutting off steam and allowing the train to run until it came to a stand-still.

The resistance on the combined grade and curve was ascertained by running the train up to stop-post No. 3 at a low speed (about 5 miles per hour), and then shutting off steam, and allowing the train to run until stop-post No. 4 was reached. The speed at the moments of passing each stop-post was carefully noted.

It will thus be seen that the resistances given below include not only the resistance of the cars, but of the engine running without steam. This is probably greater per ton than that of the cars, but the weight of the engine (about 40 tons) is so insignificant in comparison with that of the cars (700 to 800 tons) that the influence of the engine in running without steam may be neglected, and the resistances given may probably be taken to represent fairly the resistance of new empty cars:

1887.

Pattern of cars.	Brake.	Tangent. Speed. Average miles.	Tangent. Speed. Mean miles.	Tangent. Res't'ce lbs. per ton of 2000 lbs. Lbs.	Curve. Speed. Av. miles.	Curve. Speed. Mean miles.	Curve. Res't lbs. per ton of 2,000 lbs.
Penn.	Westing'e.	15	15	5.87	19	23¼	8.72
Ill. Cent.	Carpenter.	14½	15	6.22	15¾	22¼	9.09
C. B. & Q.	Eames.	11½	14¼	7.51	13¾	20	11.00
St. Jo. & St. Louis.	Hanscom.	11½	15	12.00	4	4	19.8
Average		13¼	15	7.90	16¼	22	9.60

In making this average, the Hancom results on the curve are excluded, as they are not based on sufficient data to be trustworthy. The "mean speed" is the average of the squares of the speeds.

The cars were new, and were tried empty. The Pennsylvania cars were lubricated with dope. The Eames cars, when loaded, after these trials, gave trouble from hot boxes. The great resistance of the Hanscom train was caused by the brake-shoes binding on the wheels. The brake-shoes on the Eames trains were also in some cases very close to the wheels, and apparently affected the friction of the train on the curve. The brake shoes on the Westinghouse train were hung inside; all the others were hung outside the wheels.

The trials on the curve were made between stop-posts Nos. 3 and 4. About half the total distance is on a 2°, 40′ curve (2,149 ft. radius) extending over nearly a quarter of a circle (80° 40′ 10″) and the remainder of the distance is on curves averaging about 1°, or say about 6,000 ft. radius.

The results given in similar trials of brake trains over the same ground in 1886 were as follows; the trains were, however, composed of 25 cars, 12 loaded to their full capacity and 13 empty:

1886.

Pattern of car.	Brake.	Tangent. Average speed miles.	Tangent. Rest'n'ce lbs. per ton of 2,000 lbs.	Curve. Average speed miles.	Curve. Rest'n'ce lbs. per ton of 2,000 lbs.
C., B. & Q.	Westinghouse	20½	4.32	26¼	6.07
I., D. & S.	Eames	16¾	6.84	21¾	9.42
Lehigh Val	Widdifield & Button	16¾	6.84	21¾	9.42
St. L. & San Francisco...	American	11½	8.50	21¼	8.94
Average 1886....................		16¼	6.62	22¾	8.46
" 1887..................		13¼	7.90	16¼	9.60
Average of both years.........		14¾	7.26	19½	9.03

The Committee are indebted to Mr. A. M. Wellington for the calculations giving the results of the trials in 1886.

The results for the two years agree fairly well. The average difference between the resistances on the tangent and on the curve was 1.84 lbs. in 1886 and 1.70 lbs. in 1887. One train of cars (Westinghouse, 1886) gave a resistance of only 4.32 lbs. on the tangent, while another train (Hanscom, 1887) had a resistance of 12.00 lbs. per ton on the tangent, or nearly three times that of the Chicago, Burlington & Quincy cars in the lighter running train. This difference was apparently principally due to the brake-shoes rubbing against the wheels, and was equal to a constant grade against the train of 20 ft. per mile. In running from New York to Chicago, 1,000 miles, the extra resistance would be thus equivalent to surmounting an elevation of 20,000 ft., or more than the height of the highest mountain in North America. The importance of keeping the brake-shoes clear of the wheels is thus very evident.

In the 1886 trials the Chicago, Burlington & Quincy, the Indianapolis, Decatur & Springfield, and the Lehigh Valley trains, were composed of cars that had been running some time. The St. Louis & San Francisco cars cars were new. The Chicago, Burlington & Quincy cars (Westinghouse) had the brakes hung from the trucks and inside the wheels. All the other cars had the brake-shoes hung outside from the body.

The following figures, based on the average results obtained in 1886 and 1887, show the increased friction on the curve as compared with the tangent.

	Increase lbs. per ton.
Shoes hung from the truck and inside the wheels...........	2.30
Shoes hung from the body and outside the wheels..........	2.84

These results tend to show that the resistance on curves is increased considerably when the shoes are hung outside and too close to the wheels. When the truck swivels, the shoes, being hung from the body, are lifted and brought closer to the wheels by the greater inclination of the hangers. When the shoes are hung from the trucks no such action occurs, and the shoes remain the same distance from the wheels, whether the car is running on a tangent or on a curve.

The fact that outside-hung shoes rub more forcibly against the wheels on curves, is not only shown by the figures given above, but was also observed when the trial trains were being hauled over frogs and curves in the yard at West Burlington.

The size of journal bearing has, doubtless, an important influence on the friction of trains, and the subjoined figures give the sizes of the journals in three of the trains tried at the 1887 tests, together with the weight of each car, empty, and loaded to its full marked capacity, and the resultant load per square inch on the journals. The bearing area of the journal is assumed as the length and diameter multiplied together:

Cars.	Journal length and diameter.	Weight of car.		Pressure per sq. in. on journal.		Friction tangent.
		Empty.	Loaded	Empty.	Loaded	
	Inches.	lbs.	lbs.	lbs.	lbs.	lbs.
Pennsylvania	8 × 4	30,577	90,577	119	354	5.87
Illinois Central	7 × 4	27,351	67,351	122	301	6.22
C., B. & Q.	7 × 3¾	25,509	65,509	121	312	7.51

As the frictional resistance given was obtained with empty cars, where the load per square inch on the journal is practically identical, the variation found in the resistance is due to other causes than insufficient bearing surface. The highest amount of friction was shown in 1887 by the Chicago, Burlington & Quincy cars, which in 1886 showed the least. In both years the cars were of the same design, but in 1887 the cars were new, whereas in 1886 they had run over 10,000 miles. The difference was, therefore, probably due to less accurate fitting and workmanship as compared with the Pennsylvania and the Illinois Central cars, which were also new, but showed, respectively, 1.64 and 1.29 lbs. per ton less friction than the Chicago, Burlington & Quincy cars. These differences, insignificant as they may appear, would, in running 1,000 miles, necessitate an extra amount of haulage power equivalent to surmounting summits 4,330 and 3,415 ft. high respectively, or greater than that of any line between the Mississippi and the Atlantic. The importance of good fitting is further shown by the Chicago, Burlington & Quincy cars running hot when loaded after the resistance tests.

The Pennsylvania and the Illinois Central cars were built at the company's shops, and the Chicago, Burlington & Quincy cars were built by a contractor.

Your Committee believe from these experiments that the following figures represent the frictional resistance of long trains of freight-cars, in good repair, running over a track in good condition, the weather being fine and warm and the wind light. The resistance appears to be constant at speeds of from 12 to 25 miles per hour, and does not appreciably increase with an increase of speed within these limits:

Frictional resistance, lbs. per ton of 2,000 lbs. Speeds 12 to 25 miles per hour.

	New cars. lbs.	Old cars. lbs.
On tangent	8.00	6.00
On 3° curve	10.50	8.30

Good lubrication and carefully fitted boxes and journals may, with cars that have been running some time, decrease this resistance to a minimum of 4 lbs. per ton on the tangent, while brake-shoes rubbing against the wheels, and other unfavorable conditions, may increase the friction on the tangent to 12 lbs. per ton, and to considerably more on curves. The use of outside-hung shoes seems to increase the resistance on curves when the shoes are very near the wheels.

Natural Gas in Kansas.

THE last report of the Kansas State Board of Agriculture contains an article by Mr. Robert Hay, of the United States Geological Survey, on Natural Gas in Eastern Kansas, which contains the fullest statement regarding the history and extent of the oil and gas regions of that State thus far given to the public. The history of its development is similar to the history in other places. Gas has been found in prospects for oil, and has been developed from surface indications—actual escapes from the soil or rocks—which have been known for long periods. Prof. Mudge, in his report for 1864, states that petroleum, both as oil and bitumen, is found all down the eastern tier of counties from Atchison to Cherokee. A boring of 300 ft. on the banks of the Wea, one mile from Paola, was made in 1874. In 1882, a well was bored on the Westfall place, which gave gas in considerable quantity. The driller, Mr. Warner, then formed the Kansas Oil & Mining Company, under an old lease. This has been changed to the Paola Gas Company. This company has bored some wells about the town, but three wells on the Westfall place are the sources from which it is now supplying gas as an illuminant and fuel to the town of Paola, over seven miles distant. Tested by a steam-gauge, the gas has a pressure of 66 lbs. to the square inch. The depths at which gas is obtained in these wells varies from 288 to 304 ft. Fort Scott has begun the use of natural gas, and has struck it in a well yielding four barrels per day. Southwest of that town, on the banks of the Marmaton River, gas has been escaping for at least a quarter of a century. The Fort Scott Economy Fuel Company, of which Major Knapp is the Superintendent, has drilled four wells, three of which are yielding an abundant supply of gas. The three productive wells form the apices of a triangle nearly equilateral, whose sides are just under 700 ft. in length. The distance from town is little, as the farm abuts on the city boundaries. Mains have been laid, and the gas is now in use in Fort Scott hotels, private houses, etc. At Wyandotte, or in what is now Kansas City, Kan., there are three wells of which the gas is being utilized—one at a flour mill, one at a planing mill and one at the pressed brick works. At the two former, the gas is turned into the furnace under the steam boiler and is estimated to save from 10 to 20 per cent. of the coal. At the brick works, it is used in the same way. Another well at Wyandotte is blowing off gas and some oil which are not utilized at all. There are also wells at Iola, La Cygne, Girard and Independence.

Gas in small quantities has been noticed elsewhere, and oil has similarly been found as far west as Manhattan, and many towns are now prospecting for gas and oil. Ottawa is about to begin, and a company has been formed for the purpose at Wichita and at Quenemo.

Over the border, in Missouri, oil and tar springs and wells have long been known. There is a gas well, not utilized, in Vernon county, 14 miles east of northeast from Fort Scott, and 6 miles north of Deerfield, and in Kansas City there are several, some of which are utilized.

A New Method of Making Tubes from Solid Bars.

[Paper read before the American Society of Mechanical Engineers by George H. Babcock, of New York.]

WE have all heard of the Irishman's method of making a cannon by "taking a hole and pouring melted iron around it," but it has been reserved for a German actually to do a similar, or apparently, an even more difficult thing—to take a hole and force a bar of wrought-iron or steel around it! We are familiar with the process of drilling and punching for perforating metals, but here comes a man who, ignoring all such makeshifts, by "external applications only"—as a skillful physician treats an internal congestion—rolls a hole into the middle of a solid rod, thus forming it into a tube! What makes the hole? Apparently like the boy's whistle, it "does itself."

Seriously, this is no joke. The specimens which I have the privilege of exhibiting to the Society tell their own story, and scarcely need the evidence of the eye witness who saw them made, and who loaned them for this purpose. As yet, the process has not been worked in this country, but it is in practical operation in Germany. It is the invention of two brothers named Mannesmann, of Remscheid, and the *modus operandi* is as difficult to understand and explain, as was Giffard's injector or Bohnenberger's gyroscope.

The apparatus necessary to effect the result consists of two rollers slightly conical, the axes of which are in different planes—or form two lines in a twisted surface—their nearest approach being at or near the bases of the cones. The surface of the cones may be threaded in such a way that they tend to draw a body rolling between them toward their larger ends. The bar to be operated upon should be approximately round, and its end is to be inserted while hot between the cones, its axis being intermediate at all points to the axes of the rollers. The action of the cones is to draw out and twist the bar, during which operation a hollow forms in its axis, and when the bar emerges, it is a tube with a somewhat rough but approximately cylindrical and concentric bore, the surface of which shows a decided twist.

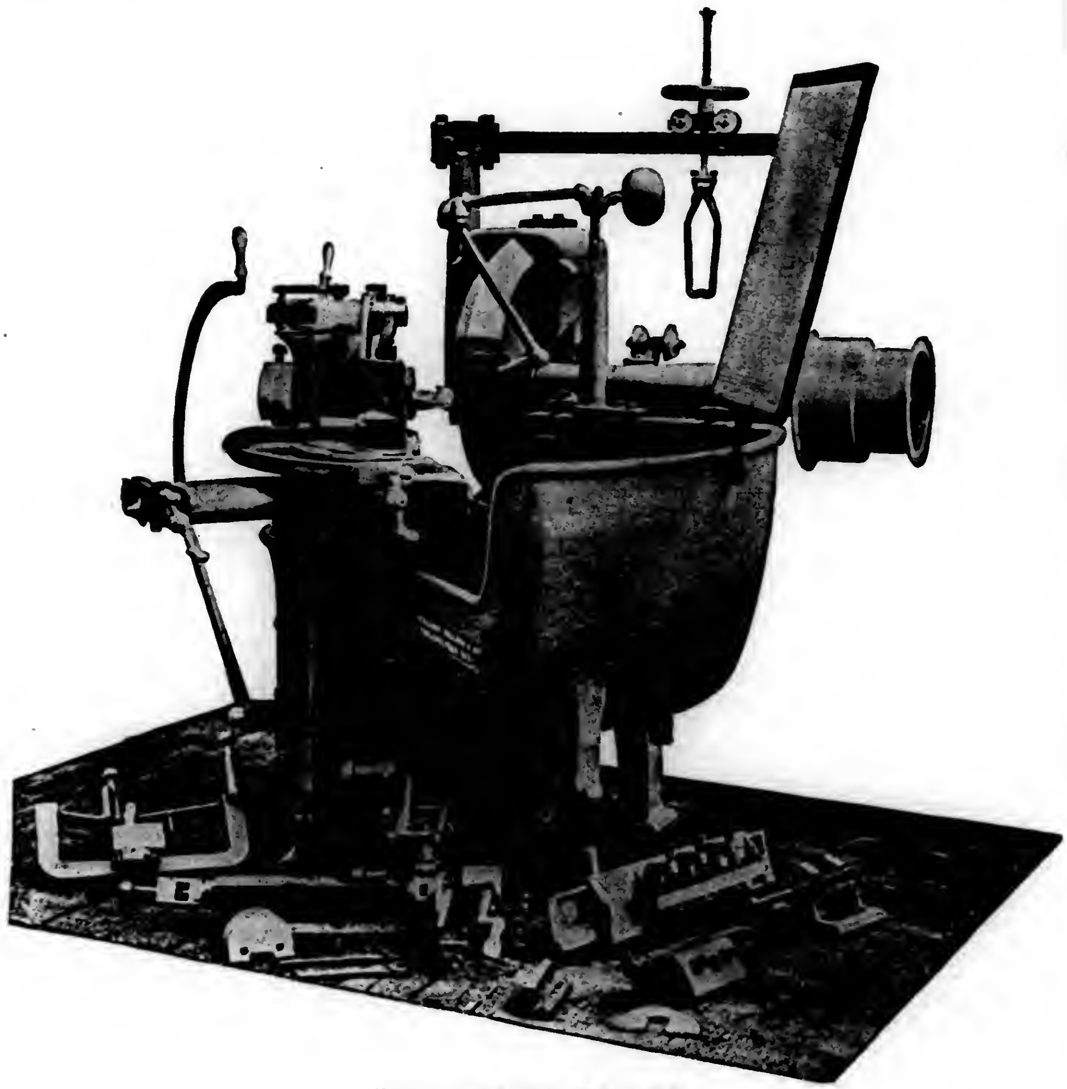
Among the exhibits is a bar which was drawn down at each end before going through the mill, so that no action took place at these ends. This bar, after cooling, was broken, and shows conclusively by the color and character of the bore, that no tool and not even the air touched it during the operation, the interior having the same appearance as the fracture.

The tubes thus formed are applicable directly for some purposes, but by a proper formation of the rolls behind the bases of the cones, or additional pairs of rolls, with suitable mandrel or mandrels, this tube may, at the same heat, be expanded and finished into a regular weldless boiler tube or gas pipe; or this may be done at a separate operation.

That the metal is not harmed by this rather rough handling may be inferred from specimens of tubes, which have undergone operations of expanding, flanging, flattening, etc., which would try the temper and quality of any respectable tube. Brass and copper tubes made by the same process are also shown.

THE SELLERS TOOL GRINDER.

EVERYONE who has ever had experience in conducting a machine shop knows how much time is taken up in grinding the cutting tools used in the lathes, planers and other machine tools; and knows also the difficulty experienced in securing anything like uniformity in the shapes of those tools, not only from the practical difficulty of making uniform shapes in the ordinary way of grinding, but also from the variety of ideas prevailing among the workmen.



TOOL GRINDING MACHINE.

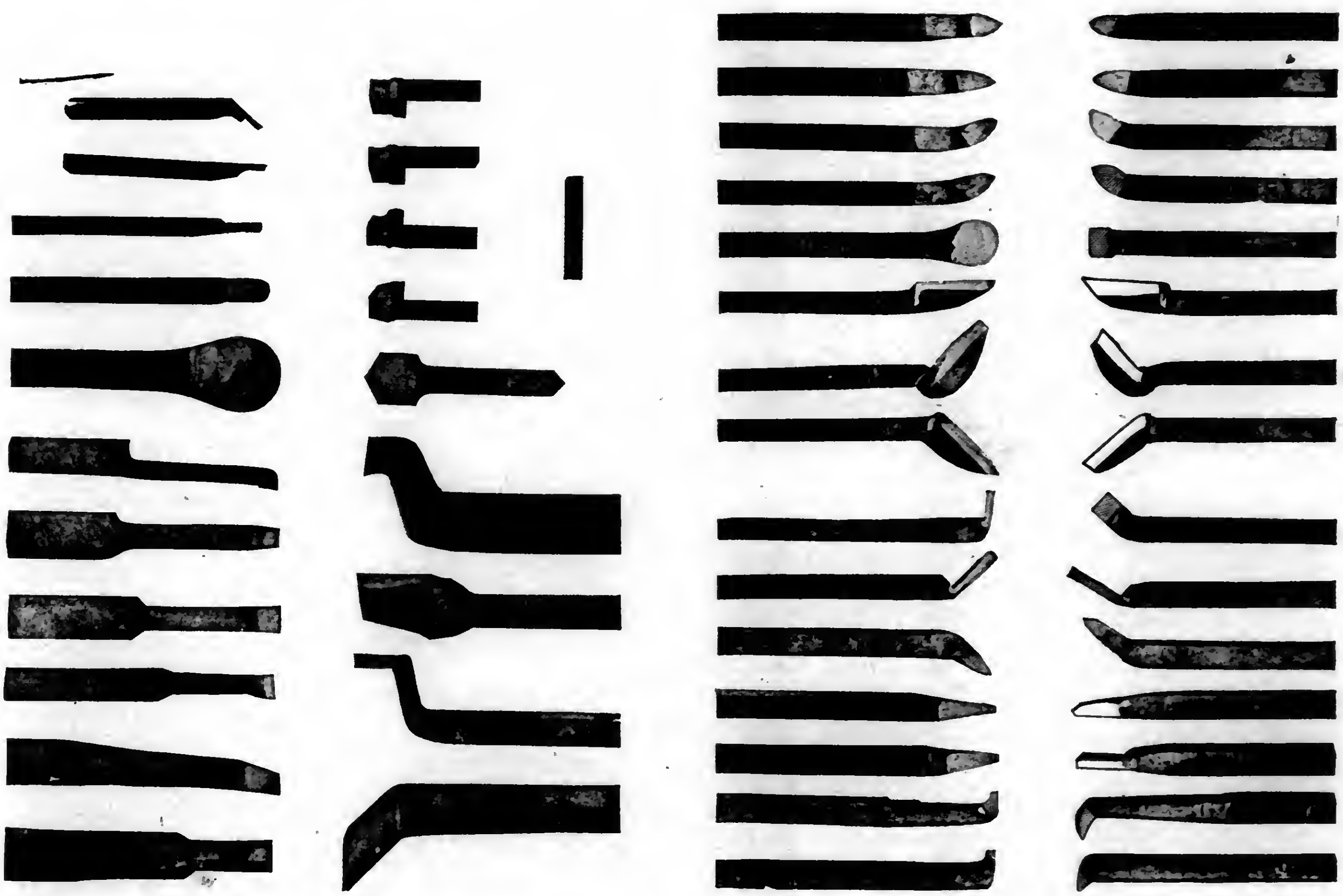
MADE BY WM. SELLERS & CO., PHILADELPHIA.

The accompanying illustration shows a grinding machine now in use in the shops of William Sellers & Co. in Philadelphia. It is the result of a gradual evolution and its present perfected form is due to a recognition of the difficulties above referred to and a determination to meet them in the best practicable way. In its present form the machine is capable of a very wide range of work, grinding and sharpening cutting tools of almost every shape that can possibly be needed. Some of these shapes are shown in the engravings printed herewith

and a still greater number might be added, were there space to give them.

The machine, as shown, is arranged with a grinding-wheel mounted in a cast-iron frame forming a large tank provided with a pump for flooding the tool with water while being ground, and with suitable shields to prevent throwing water on the working surfaces, the floor or the operator. It has slide rests, by which a vertical and two horizontal motions at right angles with each other, can be imparted to the tool-holding chuck. This machine is adapted to grind all the faces of almost any kind of lathe, planer, slotter or shaper tools. It will grind all the faces of a tool whose cutting edges are formed by the intersection of plane faces, without altering the position of the tool in the chuck. The chuck can be rotated in two gether with their angles and the position of the chuck when grinding them. 4. A diagram showing nine different shapes of either right or left hand tools and a former-plate for grinding them. This diagram gives the top-rake and clearance of seven sizes of tools from ½ in. to 2 in. of each standard shape, or 63 in all. These diagrams are those used in the Sellers Works and are the result of experience and experimenting; they can, of course, be modified to suit those whose ideas may differ. 5. A table of circular tools, from ⅛ in. to 2¼ in. diameter, which the machine grinds perfectly.

A feature of the machine is the shape of the face of the stone, as seen in the engraving. The stone is so adjusted that if the faces wear unequally it can be lifted off and reversed by merely taking a nut off from the conical



planes at right angles with each other, the exact amount of rotation being indicated by graduated circles and verniers, so that any desired angle of tool or of clearance can be accurately obtained. Means are provided by which any sample tool, whether ground by hand or otherwise, can be used as a template for grinding a "former-plate" to be afterward used for the reproduction of the shape of this sample tool.

With the machine are: 1. A chuck by which any desired curved face for roughing tools can be ground with any desired clearance. This operates in connection with a former-plate to determine the shape of the curve, and this same chuck is used without a former-plate for grinding round-nose tools. 2. A holder by means of which the base of any tool or the side on which it rests, can be readily ground to a plane surface. 3. A diagram giving the shapes of 56 different kinds of plain face tools, to-

bearing and using the small crane attached to lift the cover off and move the stone.

The machine does not require the services of a skilled machinist to run it; an intelligent laborer can quickly be taught the various adjustments required, and the work can then be done with far more certainty than by skilled labor in the old way. Very quick work can be done, and the grinder at the Sellers Works has treated 350 cutters in a day.

Besides the advantages already alluded to it may be added that, under the system in use at those works, there has been a considerable reduction in the stock of tools which it is found necessary to carry. In the case of thread cutters and special tools the saving of time and in securing uniformity has been very great. It may also be added that the use of approved forms of cutting tools results in a reduction of the power required to drive machines in use.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Continued from page 259.*)

WE continue below the record of accidents on British railroads from breakages of wheels and tires, which was begun in the June number of the JOURNAL, and the purpose and object of which were there explained. The record then closed with the year 1864, and is now taken up from that point.

ACCIDENT REPORTS.

March 21, 1865, express train on Great Western Railway was derailed near Goring by the breaking of a tire under a passenger car. The train ran over 5 miles before the engine-driver saw that something was wrong and put on the brakes. The tire gave way at the weld, which was very defective, and opened out some 13 in. It was fastened in its place by a ring or circular key riveted down over the rim of the wheel center, but when the tire broke this ring came off altogether and dropped on the road-bed. The wheel center was broken to pieces by hammering over the ties and ballast.

November 12, 1866, a mixed train on the North British Railway was thrown from the track near Spittal by a broken tire under a freight wagon. All the passenger cars left the rails, and one of them was badly broken up. The broken tire was nearly new and was 2 in. thick on the tread; it was fastened to the wheel center by four ¾-in. rivets. At the place where it broke a bad flaw was apparent in the iron.

March 23, 1867, the locomotive of a passenger train on the Glasgow & Southwestern was thrown from the track near Kirkconnell by the breaking of a driving-wheel tire on the engine, while running about 40 miles an hour. The engine ran completely off the line and upset, injuring the fireman. The driving-wheels, a single pair, were 74 in. diameter; the tire was cast-steel, originally 2⅛ in. on tread, but reduced by wear and turning off to 1¼ in. It had been shrunk on the wheel and secured to it by six tapering, countersunk bolts ⅞ in. in diameter and having a shoulder about $\frac{1}{16}$ in. some ¾ in. from the face of the tire. The tire broke through one of the bolt-holes, and there was a flaw in the steel extending from the bolt-hole to the bend of the flange. The solid metal remaining was only about one-half the sectional area of the tire. The flaw extended to the surface and might have been seen in the form of a fine crack. The engine had been in the shop three months before and had the tires turned off. In this case, the first in this list of steel tires, the Inspector says: "I understand from the Locomotive Inspector, Mr. James Stirling, that cast-steel tires were introduced on this road in July, 1861, and since that time, including the present case, four altogether have broken. * * It is apparent, from what has happened on this line since cast-steel rolled tires were introduced in 1861, that some more efficient mode of fastening such tires to the wheels than has been hitherto adopted by this company is necessary for safety. There are many methods well known, which might be adopted, free from the very obvious defect, which is inseparable from the process, of materially weakening the tires by drilling bolt-holes through them, and I cannot think that any railway company is justified in fastening tires to wheels by such a process. If, however, it be contended that the drilling of such holes does not render the tire more liable to break when it has been, as in this instance, reduced to about one-half its original thickness, it is quite evident that a much larger number of bolts should be made use of to prevent tires from flying off the wheels when they do break under such circumstances as have been detailed respecting this accident."

November 27, 1868, a passenger train on the Great Eastern Railway was thrown from the track by the breaking of a tire on a trailing wheel of the engine. The tire broke into four pieces, respectively 1 ft. 4 in., 2 ft. 7 in., 7 ft. and 7 ft. 3 in. long. One of the broken pieces threw off a carriage, injuring three passengers. The tire was Krupp steel, had been running 5 years and had been turned down to about 1¼ in. on the tread. It was fastened on the center by hammering down the rim on wedge-shaped keys. In this case, one of the hammered portions of the rim gave way, allowing a key to fall out, and the tire to begin working; this was probably followed by the shifting of the tire. The Inspector does not consider this method of fastening tires a good one.

November 2, 1868, an express train on the Northeastern Railway was derailed near Hunslet by the breaking of the tire on a leading wheel of the engine. The tire broke at the weld and came off the wheel altogether; it was of wrought-iron, originally 2¼ in. thick, but reduced to 1⅝ in. by turning and wear. It had run 14,285 miles before being turned and 1,864 miles since. It was held to the wheel-center by six ⅞-in. tap-bolts, all of which broke off close to the inside of the tire. The weld was a very imperfect one. In this case the Inspector says: "The question naturally arises whether, so long as welded tires fastened only by bolts continue to be used for the wheels of railway rolling stock, some effectual mode of testing the soundness of the welds, particularly after the tires have been turned, ought not to be devised."

October 31, 1869, a passenger train on the Vale of Towy Railway was thrown from the track between Llanwrda and Glwnrhyd by the breaking of a tire on a leading wheel of the engine. The tire broke into five pieces, 3¼, 2¼, 3, 1¼ and 2¼ ft., respectively. The tire was fastened to the center by 6 bolts, and was dovetailed on the wheel also; it was of cast-steel. The probable cause of fracture was that the tire was made of too hard steel, and was put on the wheel too tight, that is, was shrunk too much in putting it on.

June 7, 1870, seven carriages of an excursion train on the Lancashire & Yorkshire road were thrown from the track near Hoghton, and one of them went over a bank, killing 2 passengers and injuring 27. The cause was a broken tire under a carriage. It was a new tire, in use only two months, made of Bessemer steel and 1¾ in. thick on tread; it was shrunk on the wheel and secured by 4 wrought-iron rivets, tapering from 1 to ¾ in. diameter. The rivet holes were drilled. Tests of the broken tire showed that the metal was very brittle.

December 26, 1870, passenger train on Great Northern line ran off the track at Marshmoor, owing to the fracture of a tire under a brake-van. The engine broke loose and went on, but 6 cars were derailed and 2 badly wrecked, killing 8 and injuring 3 persons. In this case the tire was steel, 42 in. diameter, nearly new, and was dovetailed into the center in front, and secured at the back by 8 clips or keys fitting into a recess in the tire. There were also 4 screws, ⅞ in. diameter, running through the rim and about half the thickness of the tire. It broke in 6 pieces. From evidence taken it seems that the tire was very hard; the weather at the time was cold, and the road-bed very hard.

January 3, 1871, passenger train on Midland Great Western (Ireland) was derailed near Oranmore by broken tire under a passenger carriage. The tire broke in two places, a piece 18 in. long being thrown completely off the wheel. No flaws were found. The tire was iron, and was fastened to the wheel by Cabry's patent, one edge of the tire being grooved and fitted on to the outside of the rim of the wheel-center, and the lap on the outside of the tire being hammered down over the inside edge of the rim.

January 5, 1871, passenger train on London & Northwestern was derailed at Holme station, wrecking several carriages, injuring the guard and 5 passengers. The accident was caused by the breaking of a tire under a brake-van. An extensive flaw was found in the weld (where the tire broke) which appeared at the surface as a slight crack. The tire was originally 2 in. thick, but had been worn and turned down to $1\frac{5}{16}$ in. A second break was through a bolt-hole. The Inspector's report says: "The tire was of iron of good quality, and fixed on the inner rim of a wrought-iron wheel having 9 spokes, by means of 5 conical-headed countersunk wrought bolts ¾ in. diameter, with screw-nuts on the inside of the inner rim or sole of the wheel-center. * * The London & Northwestern and the Caledonian companies have for many years used Mansell's wheels, and I am not aware that any

case has arisen in which a tire fastened on by this method has flown. * * This accident points out conclusively that wheels with tires fastened on as this one was should not be run at all on passenger trains. It is certain that the public traveling on railways in these carriages are subjected to increased risk from this cause in very severe weather; no matter whether the liability to fracture be due to the rigidity of the road-bed, to the greater strain on the tire by its contraction from frost, to the possibility of its being more brittle in frosty weather, or to combined action of all these causes. The increased risk is certainly incurred, and it is high time—10 years since this risk was first made clearly apparent during the winter of 1860–61, and the means of avoiding it clearly pointed out by the officers of the Board of Trade—that it should be incurred no longer."

January 5, 1871, passenger train on the Manchester, Sheffield & Lincolnshire line was derailed near Huntingdon by a broken tire under a passenger carriage. Four persons were hurt. The tire was of steel, shrunk on and fastened with foJr ¾-in. rivets; it was an old tire, and was worn down to 1⅝ .n. thick on tread. It broke into 6 pieces. There was a slight flaw perceptible at one of the breaks. This accident again shows, says the Inspector, the need of better methods of fastening tires to the wheels.

January 17, 1871, passenger train on Midland line was derailed near Draycott by a broken tire under a passenger carriage. The tire was of iron, fastened on by 4 bolts, tapering from 1⅛ to ¾ in. diameter. It broke into 3 pieces. This was another case of poor fastenings.

November 9, 1871, passenger train on Great Western line was derailed near Windsor by the breaking of a wheel under a passenger carriage. This was a Mansell wheel, 43 in. diameter. This wheel is made with a steel or iron tire and a cast-iron hub, the space between being filled by an annular disk of teak wood, made up of 16 pieces, 3½ in. thick and about 15 in. long. The hub has a circular flange on one side, and a heavy washer slips over the other end, the two being bolted together by 8 bolts, holding the wood blocks at that end. On the outer end the tire is made with a dovetail on each side and two circular iron rings, which fit into the dovetail and project considerably beyond the inside of the tire. These rings are fastened by 16 bolts, one passing through each section of the wood. In this case most of the wood broke from the center, leaving an irregular rim and the tire with no center. Only one of the bolts was broken. The wheel is to be improved in the future by increasing the size of the bolts and putting in a larger hub. The Inspector calls this a very good wheel.

November 8, 1871, passenger train on Midland line was derailed near Kingsbury Wood by a broken tire on a driving-wheel of the locomotive. This tire was of steel, 6 ft. 6 in. diameter, had run 80,110 miles, and had been turned and worn down from 2⅜ in. to 1⅝ in. thick on tread. It broke into two pieces, showing an old flaw at one of the breaks.

November 10, 1871, passenger train on Midland line was derailed at Borrowash by broken tire on a locomotive driving-wheel. This tire was of crucible steel, had run 87,800 miles and had been three times turned up; it was 1⅝ in. thick, having been reduced from an original 2⅜ in. It was shrunk on the wheel-center and secured to it by seven ⅞-in. screws tapped into the tire about 1 in. from the inside. The tire broke into three pieces and was badly distorted in shape. In this and the preceding case, the want of better fastenings for the tire is blamed for most of the damage done.

November 12, 1871, express train on Northeastern Railway was thrown from the track near Learnside by broken tire on a leading wheel of the locomotive. The whole train left the track and two carriages upset, injuring 3 passengers. The broken tire was nearly new; it was of cast-steel, was 54 in. in diameter and 2½ in. thick on tread. It had a flange on the outer face bearing against the rim of the wheel-center, and was fastened to the center by four ¾-in. countersunk bolts. It broke into four pieces, It appears that the steel was very hard, so that the workmen in the shop complained that all their tools were dulled in turning it up.

December 1, 1871, passenger train on the Northeastern line was derailed near Killingworth by a broken tire under a van or "horse-box," half of the train leaving the rails and injuring 2 trainmen and 7 passengers. The train ran nearly a mile before it stopped. The tire was of cast-steel rolled out, had been running over four years and had worn down from 2 to 1¾ in. on tread. It broke into 3 pieces, 1½, 3 and 5½ ft. long, respectively. None of the breaks were at bolt-holes, but one of them showed an old flaw extending over the larger part of the sectional area. The tire had a notch or lip projecting ¼ in. over the rim of the wheel in front, and was further fastened by four ¾-in. countersunk bolts. The Inspector says: "This accident adds another testimony to the extreme importance of securing tires to wheels by some method which shall prevent their leaving them in the event of fracture. This is more needful than ever, now that the use of tires of so comparatively uncertain a metal as steel is becoming general"

December 24, 1871, passenger train on Northeastern Railway was derailed near Aycliffe by a broken tire under a passenger car. The tire was of cast-steel, 48 in. diameter and was fastened on by the Beattie method, by which a projecting lip holds the tire to the wheel-center in front, while at the back there are 9 iron clips or keys, held in place by hammering down over them a projecting lip left on the tire for the purpose. The tire broke into 3 pieces, respectively, 34, 44 and 78 in. long. From marks found it was believed that the tire first broke several miles back from the point where it left the wheel altogether. The results on the permanent way were remarkable; 200 chairs, 8 ties and 1 steel rail (82 lbs. section) were broken and had to be replaced.

February 2, 1872, passenger train on Lancashire & Yorkhire road was derailed at Cooper Bridge by a broken tire under the tender. The tire was of i cnand riveted ton the wheel by four ⅞ in. rivets. The Inspector here agai takes occasion to recommend improved methods of fastening.

September 17, 1872, passenger train on Great Southern & Western (Ireland) was derailed near Mallow by a broken tire under a passenger carriage. Of this the Inspector says: "The tire that gave away was of cast-steel, made at Leeds in 1870. It made its first journey in August, 1870. It was fixed to the wrought-iron wheel center by five ⅞ in. screw-bolts, and had been shrunk on the wheel, the amount allowed for shrinkage being 0.05 in. in the diameter. The tire showed very little wear. The grain of the metal was good; but when tried in a hydralic press, the steel proved to be brittle. It broke, without yielding, under a pressure of 35 tons applied at the center of a 22 in. bearing. * * It is impossible to prevent tires from breaking. All those hitherto manufactured have done so occasionally. It is, however, possible to prevent their leaving the wheels when they do break."

October 16, 1872, passenger train on the Midland line was derailed near Dronley by broken tire under a passenger carriage, killing 1 passenger and injuring another. The tire was of iron, 39 in. diameter and 1¾ in. thick on tread: it was fastened to the wheel-center by 4 bolts. The tire broke in 4 pieces, 3 of the breaks being at bolt-holes.

December 6, 1872, passenger train on Midland Railway was derailed near Ambergate by broken tire under a passenger car. The tire was iron, fastened by 4 conical rivets, and broke through a rivet hole. Here improved methods of fastening are again recommended.

In the period covered by the part of the summary given above, steel tires appear in considerable number, although iron tires caused a majority of the accidents and were still much more largely in use than steel. With the steel tires the greater number of accidents seem to have been caused by the use of of too hard steel, lacking in the toughness needed in a tire.

As before, the accidents were almost entirely due to the breakage of tires. Only 2 cases of broken wheel-

centers are given; 1 of those was the result of the broken tire, and the other was a wheel with wood center, which failed really because of imperfect construction, the fastenings of the wooden blocks to the hub and tire being insufficient to stand an unusual shock.

It must be remembered that the accidents here noted are only those in which the Inspectors were required to make special investigations and reports, and are not by any means all of those which happened as a result of breakages of wheels and tires.

In 1871, an act was passed by Parliament requiring railroads to make full reports of all accidents occurring on their lines. The imperfect reports for 1871 show a total of 19 broken tires and 4 broken wheels. Of the tires 5 were on locomotive wheels, 2 on tender wheels, 8 on passenger and 4 on freight cars. By these accidents 15 persons were killed and 15 injured.

For 1872 we have not the full figures, but all of the important accidents were investigated and appear in the record.

The later reports, from 1872 on, are very full and many of them are accompanied by illustrations showing methods of construction and proposed improvements.

(*To be continued.*)

English Railroad Accidents in 1886.

THE report of the Board of Trade for the year ending December 31, 1886, gives the number of accidents to trains occurring on the railroads of Great Britain and Ireland during the year, with the number of deaths and injuries to persons caused thereby; also the number of deaths and personal injuries on railroads from other causes than train accidents.

A large number of these accidents were investigated by the inspectors appointed by the Board; in all cases which were not so investigated the causes reported by the companies are given in the return as the causes of the accidents.

The number of train accidents given in the report is as follows:

COLLISIONS:		
Between passenger trains	50	
Between passenger and freight trains	53	
Between freight trains	15	
With projection from train on parallel track	1	
		119
DERAILMENTS:		
Unexplained	73	
Switches	6	
Running into gates at crossings or stations	70	
Cattle or other obstructions	125	
Land slides and wash-outs	41	
Failures of equipment	1,204	
Failure of permanent way	253	
		1,772
OTHER ACCIDENTS:		
Boiler explosion	1	
Broken springs, etc., on locomotives	7	
Fire in trains, etc	12	
Other accidents	5	
		25
Total number of train accidents		1,916

The report does not distinguish between rear and butting collisions. The failures of equipment included 8 broken couplings, 329 broken axles, 866 broken tires and only 1 broken wheel. The failures of permanent way included 247 broken rails, and 6 broken bridges, viaducts and culverts. The most frequent causes of derailments were thus broken tires, broken axles and broken rails.

Of the broken tires 18 were under locomotives, 6 under tenders, 20 under passenger cars, 18 under brake-vans and 804 under wagons or freight cars; 727 of these tires were of iron, 137 of steel, and in 2 cases the material is not stated. It is to be noted that no person was killed or injured in any of the accidents due to broken tires, and the same statement may be made as to the accidents from broken rails.

The number of passengers, employés and others killed and injured in these accidents and otherwise, was as follows:

	Killed.	Injured.
PASSENGERS:		
In train accidents	8	615
Falling from trains, etc., etc	87	727
Total passengers	95	1,342
EMPLOYÉS:		
In train accidents	4	81
In coupling or uncoupling cars	23	301
Other yard and switching accidents	96	867
Falling from trains, etc., etc	37	328
Trackmen, watchmen, etc	265	433
Total employés	425	2,010
OTHER PERSONS:		
At grade crossings	81	25
Trespassers on track	205	91
Suicides	80	...
Miscellaneous	52	71
Total, other persons	418	187

It is to be noted that 10 passengers were killed and no less than 496 injured from falling on platforms or road-bed while getting into or out of trains; a large proportion of these injuries were slight, however. Thirteen persons were killed and 17 hurt "from falling out of carriages during the traveling of trains," which seems to be a peculiarly English class of accidents.

As in this country, the greater number of employés were killed or injured in coupling cars and other yard and switching work. A very considerable number were killed and injured on trains in motion or at stations, either by falling from trains, getting on or off trains and in similar ways. Trackmen and station men seem to run about as much risk there as here.

The small number of casualties at grade crossings shows how carefully highway crossings are guarded in Great Britain. It is evident that people will walk on the tracks of a railroad, no matter how carefully it is fenced in, and that so many find such promenades fatal seems to have little effect in deterring them. Human nature is the same on both sides of the ocean, and the danger incurred seems only to increase the temptation.

The total number of casualties resulting from the operation of railroads in Great Britain last year was thus 938 killed and 3,539 injured. Of these casualties only 1¼ per cent. of the killed and 19⅔ per cent. of the injured—15¾ per cent. of the total—were in train accidents proper.

Electricity for Street Railroads.

(From the *Electrician and Electrical Engineer.*)

IT sometimes happens that a person unfamiliar with optical apparatus is best able to appreciate the magnifying power of a telescope by looking at familiar objects through its larger end, and not unfrequently the true condition of other problems may be best apprehended by viewing them inversely. Applying this method to a question of great practical importance just now exciting public interest, let us suppose a manufacturing establishment situated in the heart of a city like New York, where real estate is held at a high value, in which 150 machines, each requiring 10 mechanical horse-power, are driven by the usual equipment of engines and boilers. Now, let us suppose further that the New York State Legislature, in the exercise of the intelligent discretion which that august body invariably applies to the regulation of the internal affairs of the metropolis, should decree that on and after a certain date "It shall not be lawful to operate machinery by steam or any other power than horse-power within the limits of said city," so that it would become necessary for the proprietors of the establishment to purchase a sufficient number of animals to supply 1,500 H. P. continuously, together with the necessary additional real estate in the immediate

vicinity, whereon to erect buildings and furnish stable accommodations for the few thousand head of live stock required, and to add the cost of provender, attendance, replacement, etc. We imagine that the parties concerned would regard themselves as extremely fortunate if the cost of power under the new conditions proved to be less than five or six times as much as before. Yet the situation we have pictured, does not materially exaggerate the existing condition of affairs in respect to city transportation. A single street-railway line in New York has in service about 350 cars and 2,000 horses. Not less than 1,500 H. P. must be constantly employed in the movement of the traffic, yet it would probably be difficult to convince the managers of this or any similarly situated surface-railroad company that the whole line might be operated by a central steam plant and electric motors, at something like one-fourth the cost, for power, of the existing system. The paper of Mr. T. C. Martin, read at the recent annual meeting of the Electrical Engineers, showed conclusively that so far as the use of electric power on small roads with light traffic is concerned, the domain of experiment has already been passed. Electric traction has become a settled fact, and from present indications, nothing can be more certain than that the smaller street-railroad systems of the United States will adopt the new method as rapidly as the required machinery can be constructed and applied. In the case of lines in larger cities with heavier traffic, a similar result may be looked for at no distant day. No valid reason can be adduced why the electric system may not be applied to the more important lines with even greater proportionate economy than has been the case with small roads. It is probable that the only serious obstacle to the change will be the spirit of caution and conservatism naturally inherent in the minds of the managers of corporations having thousands and even millions of dollars invested in horse-power plant, which will lead them to ponder long and carefully before committing themselves to an innovation so radical, and necessarily accompanied with so large an expenditure. Nevertheless, the advantages of the electric system in point of economy and of public convenience must ultimately prove so controlling that it hardly seems probable that even in such cases the inevitable change will be long delayed.

Mr. Martin's summary shows that there are now running in this country 11 electric railways, equipped with 68 motors and motor cars, and that a much larger number are either under contract or in course of construction. The systems of electric distribution from a central station, both by conductors and by accumulators, have proved successful in practice, and it is difficult to imagine any difficulties of operation which cannot be surmounted by one or the other of these methods, or by a combination of the two. Investigations and comparisons of the different methods of electrical propulsion are being made by some of the largest street-railway companies in the country, and such investigations can have, we are confident, but one result.

The table given in Mr. Martin's paper, which is referred to above, we give in a condensed form below:

ELECTRIC RAILROADS IN AMERICA, MAY, 1887.

Place.	Length.	Motors.	Conductors.
Baltimore, Md.......	2 miles	6	Third-rail and overhead wire.
Los Angeles, Cal....	3 "	8	Single and double " "
Port Huron, Mich...	4 "	8	Single overhead conductor.
Windsor, Ont.......	2 "	2	" " "
Detroit, Mich.:			
Highland Park....	3½ "	2	Sunken central rail.
Dix Road..........	1¾ "	4	Double overhead conductor.
Appleton, Wis......	4½ "	8	" " wire.
Scranton, Pa........	3¼ "	3	Overhead wire.
Denver, Col.........	3½ "	7	Conduit for series system.
Montgomery, Ala....	11 "	18	Overhead conductor.
Kansas City, Mo....	..	..	....
Orange, N. J........	½ "	1	Overhead conductor.
Boston Mass.......	..	1	" "

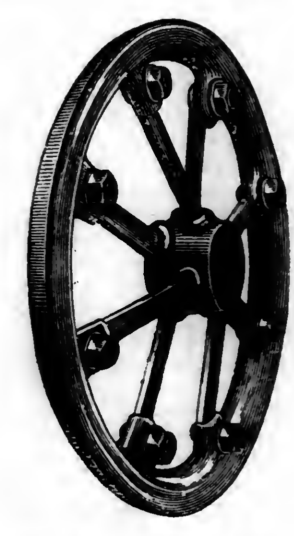
The Boston road, is a short line used for moving freight at a sugar refinery; the motor draws a load of 10 tons. The Windsor and Scranton roads take power from the electric-light stations. At Appleton a turbine wheel furnishes power to run the dynamos; at the other places steam engines are used.

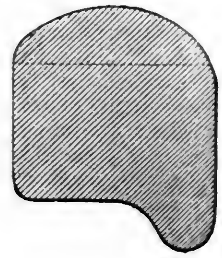
New electric railroads are now in course of construction, or under contract, at Pittsburgh (3 roads); Los Angeles; Binghamton, N. Y., 4½ miles, 8 motor cars; Lima, O., 3 miles, 6 cars; San Diego, Cal., 9 miles, four 40 H. P. motor cars; Ansonia, Conn., 3½ miles (water power); New York City (for Fulton Street); St. Joseph, Mo., 20 cars; Mansfield, O.; Ithaca, N. Y.; Harrisburg, Pa.; Woonsocket, R. I.; Richmond, Va., 40 cars, 11 miles of track.

Companies have been formed or steps taken to build and operate electric roads at Flushing, L. I. (2); Lincoln, Neb.; Brookline, Mass. (2): East Cambridge, Mass.; Newton, Mass.; Boston, Mass.; Asbury Park, N. J.; Pelham Park, N. Y.; New Brunswick, N. J.; Plainfield, N. J.; Bayonne, N. J.; Worcester, Mass.; Scranton, Pa.; Carbondale, Pa.; Philadelphia, Pa.; Reading, Pa.; Bangor, Me.; Biddeford, Me.; Westfield, Mass.; Chicopee, Mass.; Muncie, Ind.; Gratiot, Mich.; Tiffin, O.; Cincinnati, O.; Brooklyn, N. Y.; Coney Island, N. Y.; Rockaway, N. Y.; Winston, N. C.; Jacksonville, Fla.; Pensacola, Fla.; Birmingham, Ala.; Selma, Ala.; Atlanta, Ga.; Fort Smith, Ark.; Wichita, Kan.; San Francisco; San Jose, Cal.; Newton, Kansas.

An English Tram-Car Wheel.

THE accompanying illustration shows an English street-car wheel made by Thomas Firth & Sons, Limited, of the Norfolk Works, Sheffield, and shown by that concern at the Manchester Exhibition. The special feature of the wheel is that it is built up of separate parts. The tire is of cast-steel and is bolted to the flat, wrought-iron spokes by 8 bolts passing through lugs cast on the inside of the





tire for this purpose. It will be seen that there is no rim to the wheel, the tire itself forming the rim. The spokes are set in a cast-iron hub, as shown. The total weight of the wheel is 163 lbs.

It is claimed that this makes a light and strong wheel, and that there is the further advantage that when the tire is worn out it can be easily and quickly replaced by a new one.

The larger cut is a perspective view of the wheel; the smaller is a section of the tire.

A Novel Feat in Casting Iron.

[Abstract of remarks made by Mr. A. E. Outerbridge, Jr., before the Franklin Institute, Philadelphia.]

THE art of making charcoal—if, indeed, so crude a process is worthy of being dignified by the name of an art—dates back to a remote antiquity, and has been practiced with but little change for hundreds of years. It is true that some improvements have been recently made, but these relate to the recovery of certain volatile by-products which were formerly lost. Every one is familiar with the appearance and characteristics of ordinary charcoal, yet

I hope to show you this evening that we still have something new to learn about its qualities, and the unexpected practical uses to which it may be applied. We commonly regard charcoal as a brittle, readily combustible substance, but we have before us specimens in which these qualities are conspicuously absent. Take a piece of carbonized cotton sheeting, which may be rolled or folded over without breaking, and, as you see, when placed in a flame of a Bunsen burner, the fibers may be heated white-hot in the air, and when removed from the flame, the material shows no tendency to consume. Here, again, we have a piece of very fine lace, which has been similarly carbonized, and displays the same qualities of ductility and incombustibility.

These carbonized fabrics may be subjected to much more severe tests with impunity, and, when I tell you that they have been exposed to a bath of molten iron without injury, you will readily admit that they possess some qualities not ordinarily associated with charcoal. When removed from the mold in which they were placed after the iron casting had cooled, not a single fiber was consumed, but upon the face of the casting there was found a sharp and accurate reproduction of the design, thus forming a die. This die may be used for a variety of purposes, such as embossing leather, stamping paper, sheet metal, etc., or for producing ornamental surfaces upon such castings. Some of the carbonized fabrics displayed upon the table are almost as delicate as cobwebs, and one would naturally suppose that when a great body of molten metal is poured into a mold in which they are placed, they would be torn to fragments and float to the surface, even though they were unconsumed, yet such is not the case. I have found in practice that the most delicate fabrics may be subjected to this treatment without danger of destruction, and that no special care is needed either in preparing the mold or in pouring the metal. By the aid of the megascope, the enlarged images of some of these castings, showing the delicate tracery of the patterns, will now be projected upon the screen, and you can all see how perfectly the design is reproduced.

In these experiments the mold was made in green sand in the ordinary manner, and the fabric laid smoothly upon one face, being cut slightly larger than the mold, in order that it might project over the edge, so that when the molding flask was closed the fabric was held in its proper position. As the molten metal flowed into the mold it forced the fabric firmly against the sand-wall, and when the casting was removed the carbonized fabric was stripped off from its face without injury. In this way several castings have been made from one carbonized material. These castings are as sharp as electrotypes, whether made of soft fluid iron or of hard, quick-setting metal. The peculiarity is owing to the affinity between molten iron or steel and carbon; the molten metal tends to absorb the carbon as it flows over it, thus causing the fabric to hug the metal closely. It is somewhat analogous to the effect of pouring mercury over zinc. You know that when mercury is poured upon a board it runs into a globular form; it does not wet the board, so to speak, but when poured upon a plate of clean zinc it flows like water and wets every portion of the zinc; or, as we say, it amalgamates with the zinc; so, when molten iron is poured into an ordinary sand mold, which has been faced with this refractorily carbonized fabric, it wets every portion of it, tending to absorb the carbon, and doubtless would do so if it remained fluid long enough, but as the metal cools almost immediately there is no appreciable destruction of the fibers.

Mr. Outerbridge then exhibited some castings which represent a very interesting and novel experiment. In this case, the piece of lace, having open meshes a little larger than a pin's head, instead of being laid upon one face of the mold, was suspended in it in such a way as to divide it into two equal parts. Two gates or runners were provided, leading from the sinking head to the bottom of the mold, one on each side of the lace partition; the molten iron was poured into the sinking head and flowing equally through both runners, filled the mold to a common level. The lace, which was held in position by having its edges imbedded in the walls of the mold, remained intact. When the casting was cold, it was thrown upon the floor of the foundry and separated into two parts, while the lace fell out uninjured, and the pattern was found to be reproduced upon each face of the casting.

The question naturally arises: Why did not the iron run through the holes and join together? The answer may be found in the fact that the thin film of oxide of iron, or skin, as it is popularly called, which always forms on the surface of molten iron, was caught in these fine meshes, and thus prevented the molten metal from joining through the holes. The experiment has been repeated a number of times, and it is found that the meshes must be quite small (not over $\frac{1}{30}$ in.); otherwise the metal will reunite. This observation, perhaps, explains the cause of many obscure flaws found in castings, sometimes causing them to break when subjected to quite moderate strains. We frequently find little cold-shot or metallic globules imbedded in cast-iron or steel, impairing the strength of the metal, and it has long been asked: "What is the cause of this defect?" The pellicles have been carefully analyzed under the supposition that they might be alloys of iron and nickel, or some other refractory metal, but the analysis has failed to substantiate this theory. Is it not probable that, in the process of casting, little drops of molten metal are sometimes splashed out of the stream, which immediately solidify and become coated with a skin of oxide, then falling back into the stream of rapidly cooling metal, they do not remelt, neither do they weld or amalgamate with the mass, owing to this protective coating, thus forming dangerous flaws in the casting?

The process of carbonizing the delicate fabrics, leaves, grasses, etc., is as follows: The objects are placed in a cast-iron box, the bottom of which is covered with a layer of powdered charcoal or other form of carbon, then another layer of carbon-dust is sprinkled over them, and the box is covered with a close-fitting lid. The box is next heated gradually in an oven, to drive off moisture, and the temperature slowly raised until the escape of blue smoke from under the lid ceases; the heat is then increased until the box becomes white hot; it is kept in this glowing condition for at least two hours; it is then removed from the fire, allowed to cool, and the contents are tested in a gas flame. If they have been thoroughly carbonized, they will not glow when removed from the flame, and the fibers may even be heated white hot before consuming.

Of course, the method employed to carbonize the materials is susceptible of variation, but the scientific principles involved are unchangeable; they are:

1. Partial exclusion of air and substitution therefor of a carbon atmosphere.
2. Slow heating to drive off moisture and volatile elements.
3. Intense and prolonged heating of the partly charred objects to eliminate remaining foreign elements, and to change the carbon from the combustible form of ordinary charcoal to a highly refractory condition.

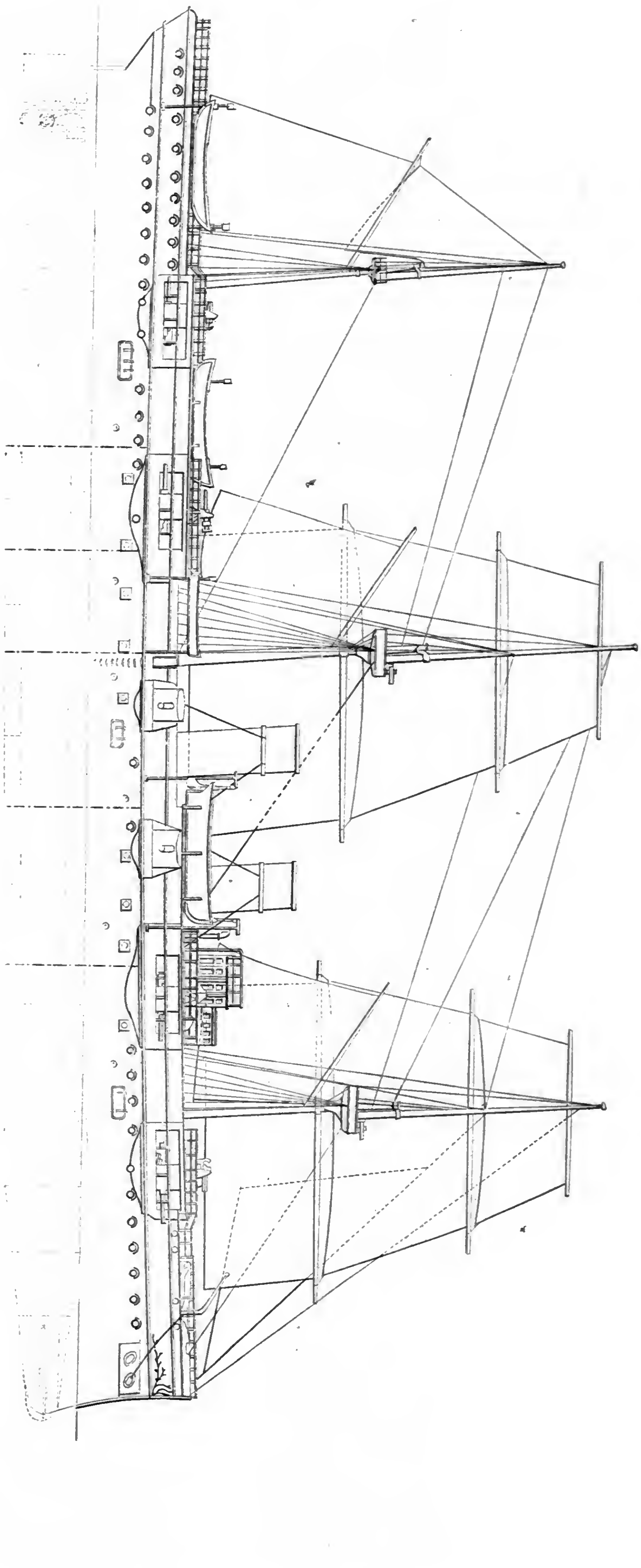
Mr. Outerbridge further states that he now has some castings made from carbonized fine damask napkins, and also from watered silk, showing that designs formed by the weaving of the threads on a flat surface can be reproduced.

THE NEW WARSHIPS.

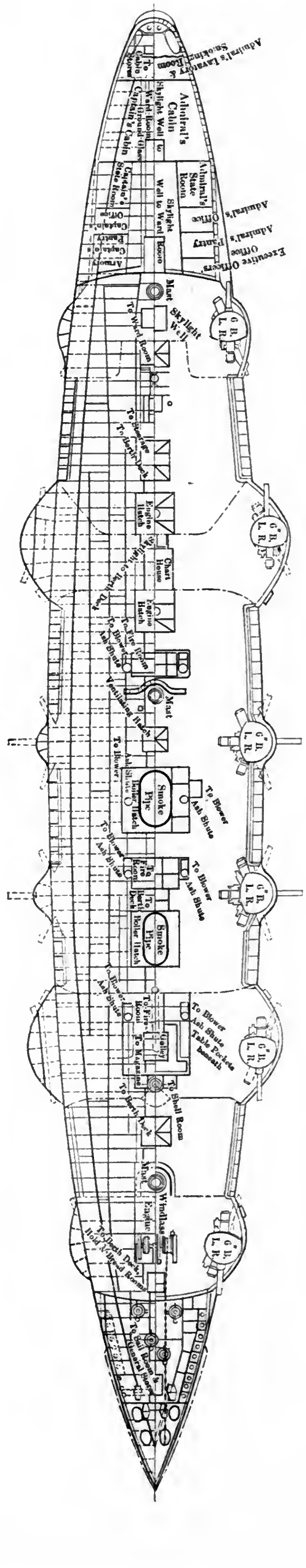
THE United States Navy Department is now inviting bids for five new vessels—Cruisers Nos. 1, 4 and 5 and Gunboats Nos. 3 and 4—from builders, whose bids are to be presented by August 1 next, and has under consideration plans for two other and heavier vessels, an armored cruiser and an armored battle-ship. For the last two bids have not yet been invited. The engravings given and a part of the descriptions are from the New York *Herald.*

CRUISER NO. 1, THE "NEWARK."

This vessel is to be a partly armored cruiser of about 4,000 tons displacement, and is to cost $1,300,000, exclusive of armament, which will be furnished by the Depart-



ELEVATION.



GUN-DECK PLAN.

CRUISER NO. 1.—THE "NEWARK"—FOR THE UNITED STATES NAVY.

ment. The vessel will be a twin-screw steamer, of steel, much resembling those described below. The first of the accompanying engravings shows an outline view and main deck plan of the *Newark*.

CRUISERS NOS. 4 AND 5.

These vessels, which are represented in outline in the second engraving given, are to be twin-screw cruisers 310 ft. long on the water line, 49 ft. 1¾ in. extreme breadth, 18 ft. 9 in. mean draught, displacing 4,083 tons. They are to have machinery of 10,500 indicated horse-power under forced draught. The maximum speed is 19 knots, rig that of a three-masted schooner, spreading 5,400 square feet of sail. They will have a double bottom extending through 129 ft. of the length. The framing in this portion is on the bracket system. Before and abaft the double bottom, above the protective deck, Z-bars form the transverse frames. The protective deck, which is 19 in. above water line amidships, is flat across the top, with sides which slope down to a depth of 4 ft. 3 in. below the water line. The horizontal portion is 2 in. thick, the slope being 3 in., reduced at both ends to 1½ in. It extends uninterruptedly forward and aft, and protects the machinery, magazines and steering gear, the machinery being further defended by the disposition of the coal bunkers. The main hatches in this deck are protected by armor bars and have coffer dams extending to the upper decks. The guns are carried on the gun, forecastle and poop decks.

The main battery will consist of twelve 6-in. breech-loading rifles, all on center pivot mounts, with 2 in. segmental steel shields, and arranged on sponsons, so as to obtain the greatest possible arc of fire. The forecastle, the poop and the bridges have been as much as possible availed of to shelter the guns. The two guns forward and the two guns aft converge their fire a short distance from the ends of the ship, and the broadside can be concentrated within 100 ft. of the side. Four above-water torpedo tubes are provided on the berth deck, and two direct-ahead under-water torpedoes in the bow. The secondary battery is composed of four 47-millimeter revolvers, four 57-millimeter single shots, two 37-millimeter revolvers and one short Gatling.

The coal capacity is 850 tons. The complement of men 300.

The vertical keel is 17½ lbs. per square foot, and 39 in. in depth amidships; the flat keel plates, 20 lbs. and 17½ lbs. The stem is cast-steel, shaped and supported for ramming. The stern post and rudder are also steel castings, the latter 15 in. in diameter at the head. Numerous water-tight frames are worked in the double bottom, and throughout the vessel the cellular principle is carried as far as practicable. At a height of about 4 ft. above the protective deck the berth deck is placed, the space between the two being greatly subdivided and mainly utilized for coal stowage. Bilge keels 24 in. in depth extend for 150 ft. of the length. When in action, the vessel will be directed from a conning tower of steel, 3 in. thick, cylindrical in form, located on the forward bridge. There will be a wooden pilot house located on the forward bridge just abaft the conning tower and arranged to overlook the latter. The tower will be fitted complete with steering wheel, speaking tubes and engine-room telegraph; these will be carried below the protective deck through a steel tube 2½ in. thick and 12 in. diameter. A steam steerer will be located beneath the protective deck.

The arrangements for pumping and drainage are very carefully considered. The system followed may be described as a development of that employed in the *Chicago*. Pumps are connected with all the important compartments. All the principal water-tight doors and the sluice valves are arranged to work from the berth deck.

The ventilation is much more elaborate than in the small vessels. Natural ventilation is favored as far as possible, but, in addition, all living and other spaces below the main deck are carefully ventilated on the exhaust system, the blowers being entirely distinct from those used for producing the force draught in the fire-room. Large ducts extend forward and aft on the protective deck, receiving smaller ducts from the various rooms and compartments. Where these ducts pass through bulkheads automatic valves are fitted to prevent the flow of water from one compartment to the other by way of the air-pipes. The coal bunkers are well ventilated, the fresh air supply to the bunkers being obtained through pipes carried up into the hammock berthings.

The ceiling in the hold will be of yellow pine battens, and on the berth deck steel-plate will be used, secured to the reverse flanges of the frames by brass screws. The ward room will be finished in sycamore, without pilasters, but with suitable moldings and panels.

There will be two complete electric lighting plants, arranged to work on the same circuit, and lights are to be disposed so as to fully illuminate all parts of the ship, including coal bunkers, magazines, shell and ammunition rooms, running lights and lights for use on the upper deck and aloft. The total number of lamps will be about 400.

These vessels are to cost not over $3,000,000 together. The builder is to guarantee a speed of 19 knots per hour, forfeiting $50,000 for every quarter knot below that point and receiving $50,000 for every quarter knot in excess of it made by the vessel on trial.

GUNBOATS NOS. 3 AND 4.

These vessels (which are not illustrated) are to be substantially the same as gunboat No. 1. They are to be twin-screw vessels, having a length on the load line of 230 ft., an extreme beam of 36 ft. and a displacement at 14 ft., mean draught of 1,700 tons. The machinery is estimated to indicate 2,200 H. P. with natural, and 3,300 with forced draught. There are two independent, compound engines, placed in separate compartments. The cylinders are 29 in. and 52 in. diameter, and 30 in. stroke. There will be two three bladed propellers, 11½ ft. in. diameter; a grate surface of 240 sq. ft. The speed is stated at 16 knots, but it is hoped that on the measured-mile trials this will be considerably exceeded. The rig will be that of a three-masted schooner, with an area of plain sail of 4,409 sq. ft. Four hundred tons of coal will be carried. The complement will be 150 men.

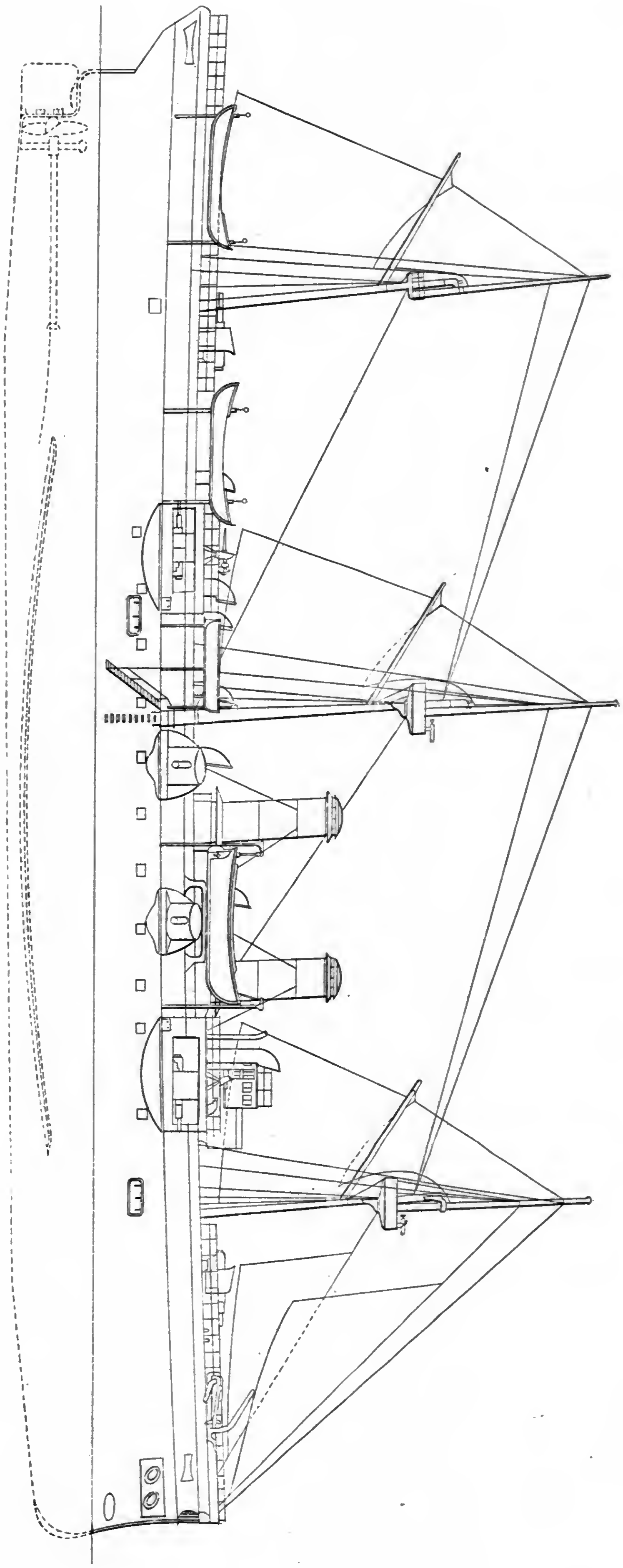
The main battery is composed of six 6-in. breech-loading rifles; the secondary battery, two 57 millimeter rapid-fire guns, two 37 millimeter revolvers and one short Gatling gun. The large guns are mounted on sponsons overhanging the ship's side, by which arrangement the arc of fire is greatly increased. There is a long poop and forecastle on which four of the 6-in. guns are mounted, two forward and two aft, at a height of about 18 ft. above the load line. The other two 6-in. guns are carried on sponsons amidships at a height of about 10 ft., and have an arc of fire of 70° before and 70° abaft the beam.

All are on central-pivot mounts, and the gunners are protected by segmental shields. The forward and after guns converge 300 ft. from the pivots, and on the broadside three guns may concentrate their fire at a distance of 100 ft. from the side.

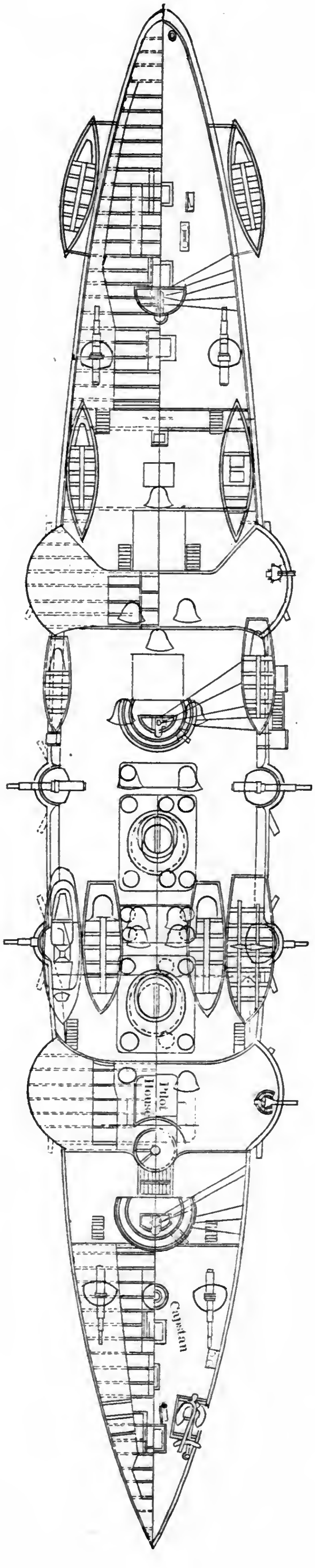
The torpedo armament is of great relative importance. No less than eight torpedo discharge tubes will be fitted —one in the stem and one in the stern being fixtures. The six in broadside are capable of training forward and abaft the beam.

These ships are to be built entirely of steel. The vertical keel will be 15 lbs. per square foot, and in depth 25 in. The flat keel-plates are double. The stem and stern posts are of cast-steel. The transverse frames are to be 24 in. apart and are composed of Z-bars, having the advantage of strength and lightness, desirable in warship construction. Forward and aft throughout the length of the vessel a water-tight deck ⅜ in. thick will be constructed. It will be arched with a spring of about 3 ft. in its greatest width, and will be so disposed that the crown comes nearly on the water line. This deck will rest on angle beams 5 × 2½ in. The main-deck beams are of T-section, 6 × 4½ in., and those of the berth deck of angle bars 3½ × 2½ in. The outer plating varies in thickness, according to its position.

Protective plating 1 in. thick is worked in the wake of the torpedo ports and machine guns. All water-tight work is to be calked metal to metal, and the interposition of any canvas or felt is prohibited. Bilge keels, projecting



ELEVATION.



PLAN OF POOP DECK.

CRUISERS NO. 4 AND 5, FOR THE UNITED STATES NAVY.

18 in., will extend for about 100 ft. amidships, and are being fitted to all of the new vessels, as they are found to materially reduce rolling without causing much increase of resistance. There is no double bottom, but the number of compartments is large, and the arrangement of water tight doors is very satisfactory, all the important ones being contrived to open and close from the main deck.

Coffer dams will be built about the engines and fire-room hatches and carried up to a height of 18 in. above the main deck. When in action the vessel will be steered from a conning tower located on the forecastle deck and built of mild steel 2 in. thick. There will also be a wooden pilot house for ordinary use, fitted with chart tables, speaking tubes, etc., to communicate from the conning tower to the engine-rooms, torpedo-rooms and stations, all steering wheels, main and secondary batteries, masthead and other electric search lights and cabins. In addition to hand-gear, steam steering-gear will be fitted.

The ventilation of the living spaces and the hold will be by a carefully considered scheme of natural currents utilizing the frame spaces, louvres and cowls being fitted along the top sides, communicating with the spaces below by appropriate ducts. The vitiated air of the engine-room will be withdrawn by the fans used for forced combustion. Special ventilation is provided for the bunkers, trunks being led to the chimney casing to exhaust the explosive gases given out by the coal. The ward-room joiner work will be in sycamore veneering, ¼ in. thick, with a dead finish; each stateroom will be neatly furnished; the berth fronts are made to turn down, and drawers and lockers are fitted underneath; the under side of the deck in ward and staterooms is paneled; the locks are brass, and the hinges and knobs of bronze; the cabin under the poop will be furnished in the same manner; the ceiling on the berth deck forward will be of thin steel, secured by screws to the frames, for ready access to the plating for inspection and painting; two incandescent lighting plants are arranged to work on the same circuit, each to be in all respects a duplicate of the other. The cost of these vessels, exclusive of armament, but including equipment, is limited to an amount not exceeding $550,000 each.

THE ARMORED CRUISER AND BATTLE-SHIP.

The Board to which were referred the plans of the armored cruiser and armored battle-ship presented by various parties in April last, has made the following report to the Secretary of the Navy:

"The Board appointed by the Department's order of April 22 has considered the plans of armored cruisers submitted by the Barrow Shipbuilding Company, by William John Barrow, England; Lieutenant W. I. Chambers, United States Navy; M. T. Clayton, Auckland, N. Z.; A. H. Grandjean, St. Nazaire, France; Naval Constructor S. H. Pook, United States Navy; George P. Frothingham; the Thames Iron Works & Shipbuilding Company, by I. C. Mackron, London, England; Captain L. Tonns, No. 164 Maiden Lane, New York. And of armored battle-ships submitted by the Barrow Shipbuilding Company, by William John Barrow, England; William Douglass, Galveston, Texas; Francis L. Norton, No. 633 F Street, N. W., Washington; the Thames Iron Works & Shipbuilding Company, I. C. Mackron, England; Captain L. Tonns, No. 164 Maiden Lane, New York; John Watt, Birkenhead, England; and has the honor to report:

"The plans of M. T. Clayton, Captain L. Tonns, William Douglass, Francis L. Norton and John Watt do not conform to the requirements of the Department's circular.

"The marked differences in the essential features of the designs of armored cruisers of the Barrow Shipbuilding Company, Lieutenant W. I. Chambers, A. H. Grandjean and the Thames Iron Works & Shipbuilding Company prevent their classification in the order of merit; each exhibits features which strongly commend themselves, but the Board does not consider it advisable for the Government to build a vessel upon any one of these plans.

"The Board approves the design of an armored battle-ship submitted by the Barrow Shipbuilding Company, and is of the opinion that such a ship would be a valuable addition to our Navy. The estimates and results of calculations of the design of this battle-ship have been verified by comparison."

The Secretary has, so far, taken no action on this report of the Board.

Steel Castings for War Vessels.

(From *Industries.*)

THE use of castings in the place of forged material has been gradually increasing for some years, a great impetus being given to the change by recent improvements in the method of casting. It has even been anticipated that cast-steel might displace forged iron in the stern-frames of ordinary mercantile steamers; but, however it may be in the future, this has not as yet been generally ealized. No doubt the cost of pattern-making (a separate pattern and mold being required in practice

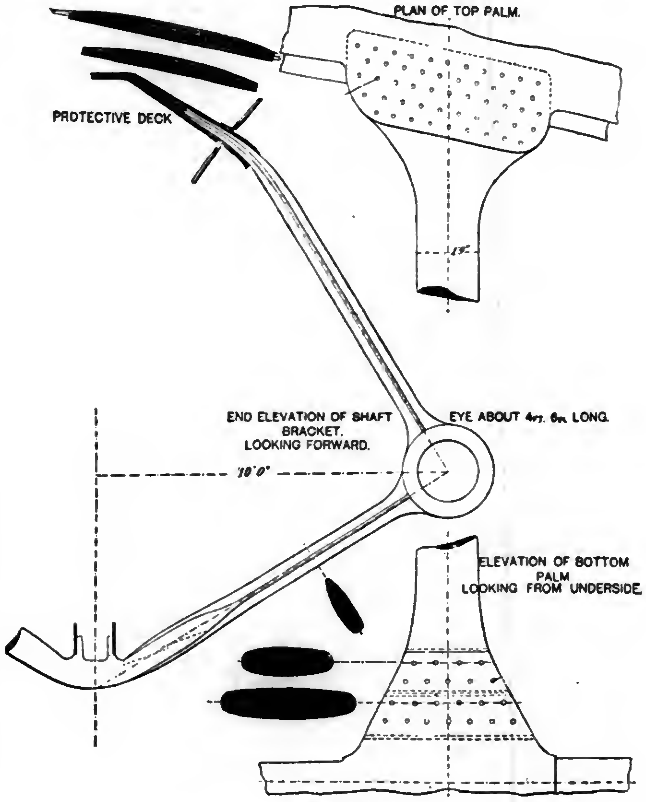


FIG. 3.

for every stern-frame) militates against the abandonment of forgings for castings; but the stems and stern-frames of war vessels, owing to their constantly varying sections of material, and the accuracy with which curved lines have to be reproduced from intricate set-offs, together with branching connections, can now be produced as steel castings at much less cost than when forged, despite the heavy expense of making a complete pattern.

In a certain class of mercantile steamers, it will usually prove advantageous to have the stem at least of cast-steel. Those who have had experience with the stems of flat-plated keel steamers, know well what anxiety there is connected with them, as to whether they are made correctly and according to instructions, and as to the difficulty of getting them accurately into shape, when being bent on the blocks in the shipbuilding yard. In future, it would seem there need be no such anxiety, as the casting of these parts has been brought well nigh to perfection. The large steel castings for H. M. S. *Orlando* and *Undaunted*, consisting of the stem, stern-frame and propeller-shaft brackets, as well as a large number of steel forgings for the engines, have all been manufactured by Messrs. John Spencer & Sons, at their Newburn Steel Works, Newcastle-on-Tyne. Full-sized drawings

on thin boards, with sections as shown, were prepared in the molding loft at the shipbuilding yard, and from them the molds for the castings were made. In the case of the propeller-shaft brackets, to insure absolute accuracy, a template was prepared by the shipbuilders and tried in place, after the stern-frame of the *Orlando* had been erected, and before the molding or casting of the brackets had been put in hand. The accuracy with which the molds, and subsequently the allowances for contraction of the castings in cooling, were made, is evident from the fact that there was practically no chipping or hammering necessary when the finished stem, stern-frame and propeller-shaft brackets were delivered into the shipbuilder's hands. The stem of these vessels is shown in fig. 1, and, as will be readily seen, is of the ram type. It consists of two pieces, the lower, of cast-steel, alone being represented. The upper portion, of an ordinary bar section with the fore end swaged, was forged at the works of Palmer's Shipbuilding & Iron Company, Limited. made to the keel. It will also be noticed that the keel gradually rises toward the after end, in a length of 18 ft. to an extent of 2 ft. The palms projecting on each side of the keel piece are for effecting connection with the propeller-shaft brackets, and add materially to the difficulties of the casting. In the case of a forging, it would be extremely difficult to make sound and accurate work, since the irregular and frequent heating and cooling cause initial strains to be set up, which even careful annealing will not remove, while such treatment damages and destroys the fibrous nature of the material. The subsequent machining, which occupies much valuable time, and necessitates the use of large and expensive tools, renders the comparative cost of forgings much more excessive than that of steel castings. It will be noticed that, to strengthen the union of the keel-piece and the stern or rudder-post, a knee or fillet, 1½ in. thick, forms part of the casting, and a similar one is fitted at the top of the stern or rudder-post to strengthen the platform, and connect

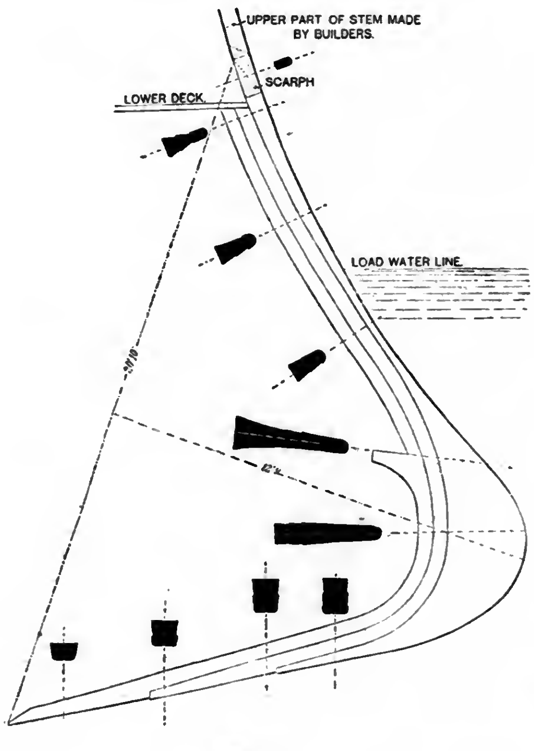


Fig. 1.

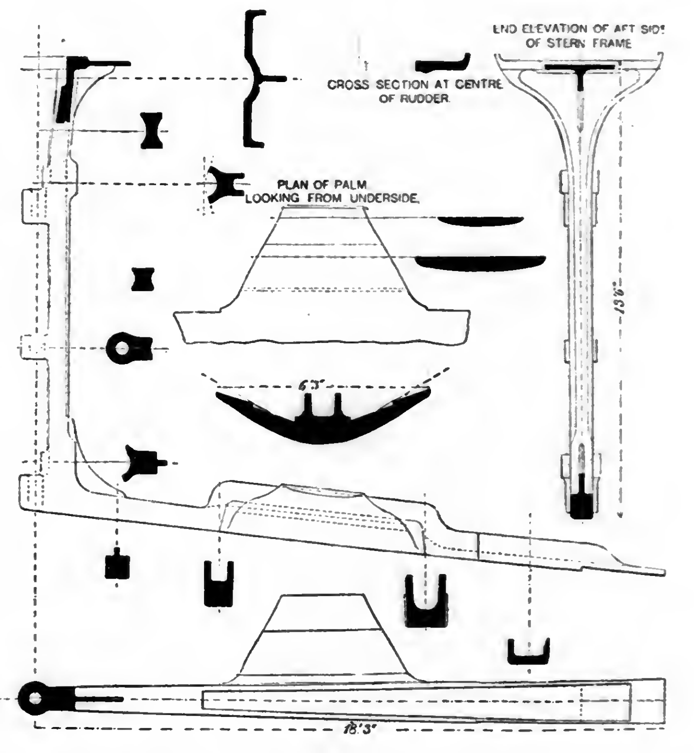


Fig. 2.

STEEL CASTINGS FOR SHIPS.

It will be noticed that, throughout the greater portion of this casting, there are two molding edges, so that the shell-plating might make a flush finish, obviating the necessity of thinning away the edges of the shell-plating where they overlap and abut on the stem. The width of the stem at the root of the scarf is 6 in., but immediately beneath the lower deck it is increased to 1 ft. 4 in. in width. The thickness, which is 2½ in. at the upper part of the casting, is gradually increased to the normal thickness of 5 in., and to greater thicknesses according as the form of the vessel requires, ranging up to 10 in. Sufficient sections are shown in the figure to illustrate the different scantlings of this casting. In the way of the ram, the width of the stem is increased to 3 ft. 2 in., and at the breast-hook connection to 3 ft. 4 in., while below the ram it gradually diminishes to 4½ in., and at the extreme end to 1 in. The length of the stem piece, measured on a diagonal line, is 20 ft. 10 in., and the weight of the casting a little over 4¾ tons.

The stern-frame is illustrated in fig. 2, and will be seen at once to show even greater intricacy in its construction, despite the absence of curvature, than does the stem-casting. For 30 in. at the fore end of the stern-frame casting, there is a recess for the flat-plate keel on the under side, so that a more efficient connection is thus the rudder-trunk. This platform is a detail of great importance, not generally provided in ordinary mercantile steamers, so that it is a frequent source of complaint that at this portion of a steamer there is considerable leakage. There are three gudgeons for receiving the rudder pintles, on two only of which does the rudder bear. Each of these is 12 in. deep, while the remaining one is 8 in., and they are all cast to nearly the finished size, thus reducing the boring out to a minimum. Above the upper gudgeon, the stern-post is gradually set forward, to accommodate the rudder-head, which is of a larger diameter than the pintles. The total weight of the stern-frame casting, in each of the belted cruisers, was 8 tons 6 cwt. The propeller-shaft brackets are shown in fig. 3, which gives a complete sectional view of one bracket, as well as plans showing the palms by which the bracket is connected to the hull of the vessel. The brackets are of the normal scantlings of 21 in. wide, 7 in. thick, the width being increased at the eye, or bearing for the shaft, to 4 ft. 6 in. As far as possible, the edges are tapered or rounded off, to lessen the resistance of the vessel. Comparing the views of the scarf for the lower palm with those of the propeller-shaft brackets, as given in figs. 2 and 3 respectively, a good idea may be formed of the care that has been taken to make the connection as efficient as possible.

This is a matter of no small importance, seeing that through each propeller shaft from 4,000 H. P. to 5,000 H. P. will be transmitted. Four rows of rivets, 1⅝ in. diameter, spaced about 7½ in. apart, complete the attachment, as shown in the elevation of the bottom palm, which is increased in width, gradually, to 4 ft. 10 in. The upper palm passes into the hull, and abuts on the terminating portion of the protective deck, as shown. This palm is 5 ft. 10 in. in length or width, and is supplied with relatively greater rivet connection, in this case 1¼-in. rivets being used, spaced about 6½ in. apart. Two rows pass through plates, projecting for the purpose beyond the hull of the vessel, one row through double angle irons and plates inside the shell-plating, and two other rows further in-board; the whole forming a very strong attachment, which it is anticipated will quite suffice for the enormous strains to be developed when the vessel is under full steam. Each of these brackets exceeds 8 tons in weight. By the courtesy of Messrs. Spencer & Sons, we are enabled to give a summary of the tests which were undertaken in connection with the steel employed for these castings. Each of the castings was drop-tested, by lifting it up with a steam traveling crane to a considerable height. It was then allowed to fall upon a macadamized road surface. Each of them was also lifted up, having one end resting on the road, and the other end forming an angle of 60 deg. with the surface of the road, and dropped from this position. Having been subjected to these severe tests, each casting was suspended and hammered with heavy hammers to try its soundness, and in every instance with the most satisfactory results.

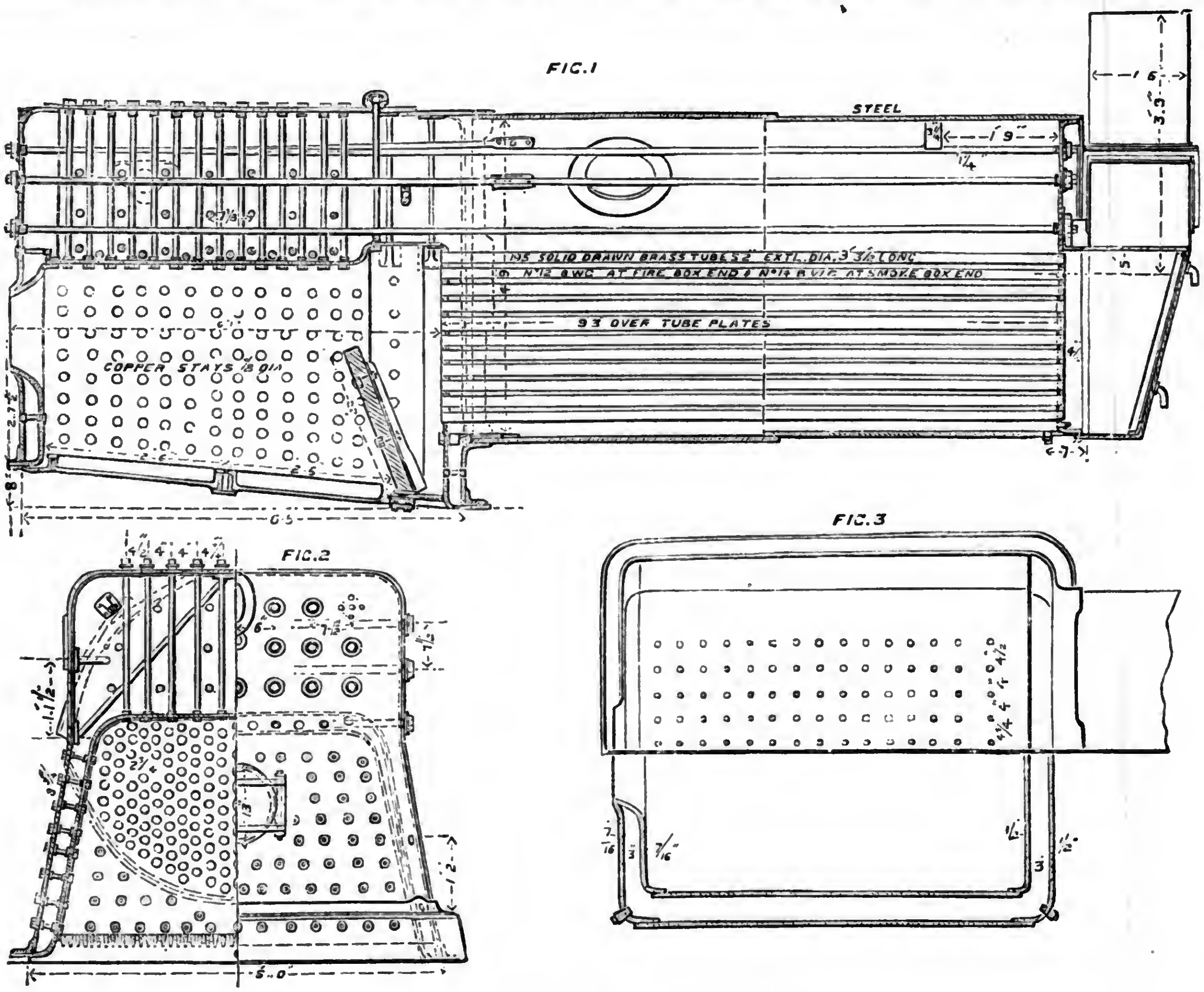
A stern-post for one of the new gunboats was recently made by the Standard Steel Casting Company, the first casting of this kind, we believe, ever made in the United States.

Casualties in Torpedo Boats.

(From the London *Engineering*.)

We told our readers in our last impression the story of the explosion of a boiler on board a torpedo boat. At the time we went to press our information was scant. Official, and, we may add prudent, reticence interfered to prevent anything like a detailed statement of the truth. Since we wrote, the facts have become public; and they are far more serious and important than appeared at first sight. The Admiralty wisely determined to test a flotilla of torpedo boats purchased for the Navy at various times. The test was different from anything made before. Hitherto boats have been tried as weapons of attack and defense. Their sea-going qualities up to a certain point have been made the subject of experiment; but nothing was really known concerning their powers of endurance when steaming at full speed in charge of naval engineers. Now it is obvious that in case of actual war our torpedo boats might be called on to steam long distances in order to repel a threatened attack, and it is also clear that under such circumstances they would be called upon to go from place to place as fast as they could go. It was decided for these reasons that the boats of the flotilla should race over a distance of about 100 miles. * * * *

Opinions differ as to the value of torpedo boats, but it is certain that no maritime power could be without them; and the fact that, out of 24 British boats, no fewer than 8 were rendered *hors du combat* as soon as they were worked under conditions which might—and probably would—obtain any or every day if we were at war, is extremely serious. The failures we have recorded possess a national importance. It is a noteworthy fact that all the boats which broke down were by the same firm. There were 4 boats by Messrs. Yarrow & Co., 3 boats by White,



THE YARROW TORPEDO-BOAT BOILER.

of Cowes, the remaining 17 were by Thornycroft. If we refuse to class the failure of a propeller as a breakdown because the boat was still able to proceed, though at reduced speed, we find that the casualties to the boats of the Chiswick firm came to over 41 per cent. If out of 100 torpedo boats 41 are to become unserviceable within an hour after they proceed to sea, confidence in the utility of such craft will be weakened. It may be urged—and has already been urged to some purpose—that the failures were due to the incompetence of the men in charge. If this were wholly true it would imply a very serious indictment of the Admiralty; we refuse, however, to believe it. While we admit that had more care been exercised in the stokeholes it is possible that no breakdown would have occurred, we hold that any system of design or construction which renders boilers and engines dependent for their

In No. 47 the failure was sudden and complete; and, as we know, lives were lost. In the case of No. 57 the failure of the crown plate was not so sudden and complete, and no lives were lost; although the risk incurred was awful. Why did the furnace crowns come down? The first reply that will suggest itself to an engineer is that they came down because the boilers were short of water. On this point, however, there is a great deal to be said; and in order that our readers may comprehend the whole matter, we give here two sets of drawings—figs. 1, 2 and 3—showing the system of construction adopted by Messrs. Yarrow & Co.; and figs. 5, 6 and 7, that used by Messrs. Thornycroft & Co.

At first sight there does not seem to be much difference between them, but there is a difference—a most essential difference in detail. It will be seen that in neither boiler

FIG. 5

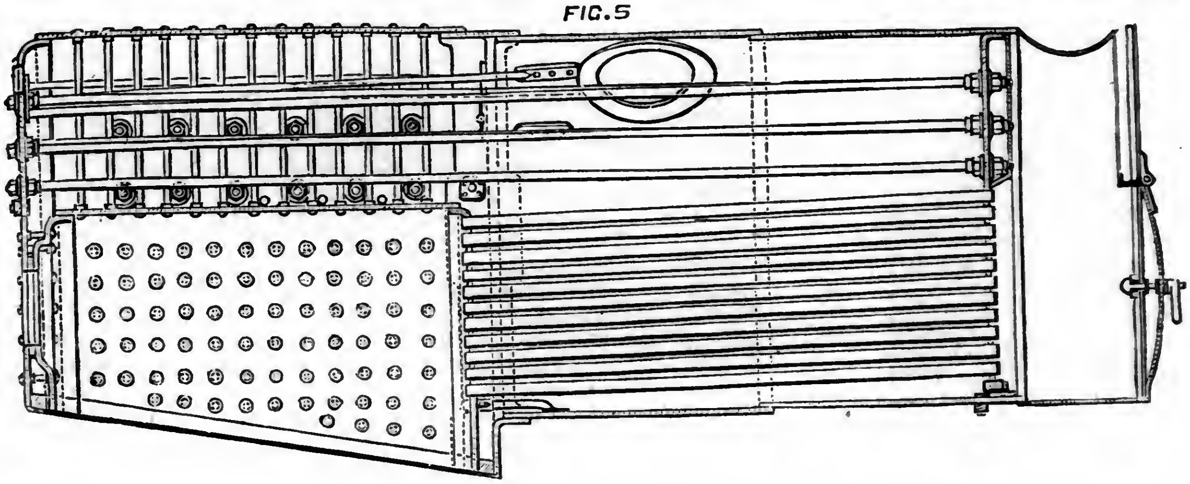
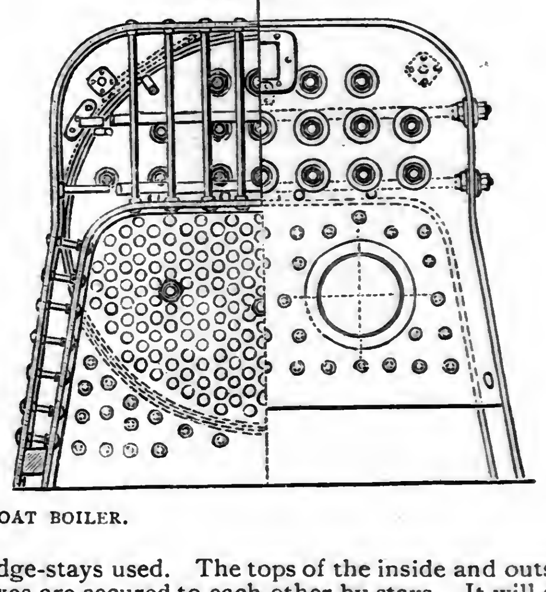


FIG. 6



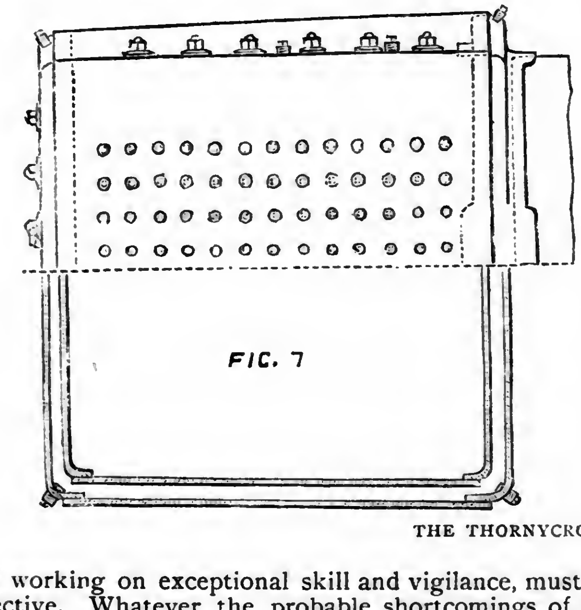


FIG. 7

THE THORNYCROFT TORPEDO-BOAT BOILER.

safe working on exceptional skill and vigilance, must be defective. Whatever the probable shortcomings of the crews in charge could possibly have been, we think the main cause of the failures must be sought and found in the machinery of the boats, and even in the boats themselves, and we fancy, before we have done, that our readers will be of the same opinion. As we know nothing yet of the nature of the failures which took place in the engine or boiler rooms of Nos. 27, 41, 50, 42 and 55, we can say little about them. No. 27 had hot bearings; but they must have been very hot indeed to stop the boat. The bearings in a torpedo-boat engine are so comparatively small and light, and the appliances for cooling so perfect, that, as is known from experience, a very hot bearing can be cooled in a very few minutes; and in a long race, such as this under consideration, 5 minutes' delay at the outset could not destroy the chances of a boat. Putting this on one side, however, we may confine ourselves to two casualties, namely, the failure of the boilers in No. 47 and No. 57. In both cases the crowns of the fire-boxes came down.

are bridge-stays used. The tops of the inside and outside fire-boxes are secured to each other by stays. It will also be seen by fig. 8 that the stays used by Messrs. Yarrow have large heads jumped up out of the solid and forged to shape; that under these heads is a screw thread; that the opposite ends or points are also screwed. The stays are turned down between the threads, so that the threads stand up. These bolts are then screwed hard into place from the inside, and large square nuts are then screwed on the ends projecting on top of the fire-box shell. In locomotive work the crown-stay bolts always have heads or nuts inside the fire-box on the crown stays.

Turning now to Mr. Thornycroft's boiler, it will be seen by fig. 4 that he dispenses with nuts and heads. His stays are screwed, just as Mr. Yarrow's are, but there the resemblance ceases. The ends of the stays are riveted over—the crown-stays thus resembling the side-stays. This we regard as an essentially weak system of construction, and to it we believe the failure of the boilers in Nos. 47 and 57 was partly due. The system of riveting

over cold answers well enough in a side-stay which is not more than 6 in. or 7 in. long over all; but the crown-stays are over 2 ft. long, and riveting up cold has a very great tendency to do more harm to the screw thread in the $\frac{7}{16}$-in. crown plate than anything else, for it is next to impossible properly to hold up a bar 2 ft. long to the riveting hammer. It may be urged that a screwed and riveted stay is just as strong as a screwed stay with head and nut. This we deny. That it may be quite strong enough under ordinary circumstances is one thing; that it is strong enough for torpedo-boat boilers does not at all follow as a legitimate consequence. It will not do to assume that, because such a system of construction may give good results in a locomotive boiler, it must do so in a torpedo-boat boiler. It has been urged that the crown-plates came down in No. 47 and No. 57 because the plates were overheated from shortness of water. This we concede at once, but it does not follow that the men in charge were to blame. As a matter of fact, the crowns of the fire-boxes in torpedo-boats are often left uncovered by water for some little time. When running before a sea, the boat will get on the back of a wave traveling at nearly her own pace, and she will run with her head down and her stern up until she has outpaced the wave. During this time the crown of the fire-box may have no solid water on it; but besides this, torpedo boats are so lively and jump about

FIG. 8

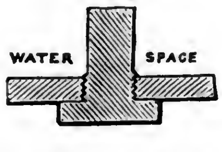
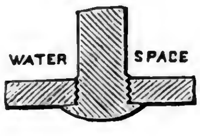


FIG. 4



so much that in a heavy sea the crown-plates are sure every now and then to get left dry, or nearly so, for a few seconds, unless the water is kept high in the glass. If there are large nuts inside the box, these serve to keep cool considerable areas of metal just round the screw-threads. It is well known that it is practically impossible to make a nut red hot if the stay remains cool, because the stay serves to convey away heat in a way very clearly set forth by Peclet, Wye Williams and others. Every engineer will concede, we think, that if the top of a Yarrow box became overheated, it would be likely to come down between the stays in pockets; but it is evident that it must be made very hot indeed before the heads could be forced off the stays or drawn right through the plate. It is, we think, incontestable that the Yarrow system must be stronger than the Thornycroft system. A leak might be started by the crown-plate cracking, but its total disruption is to the last degree unlikely. It must not be forgotten, however, that these are the first failures of Thornycroft boilers that have taken place, and that the old *Lightning* has given no trouble and has been very hard worked. But the *Lightning* has been managed by men of great experience.

We have little doubt that Messrs. Thornycroft's other failures have been due to the desire to make the machinery of their boats as light as possible. It is a matter of interest to know that the Yarrow boats of the same dimensions weigh nearly seven tons more than the Thornycroft boats. Of this 3½ tons go to the hull and 3½ tons to the engines and boiler. For example, it will be seen by fig. 1 that Messrs. Yarrow & Co. raise the forward end of the internal fire-box. They thus get room for more tubes without raising the crown plate as a whole. The small portion actually raised being near the mid-length of the boiler, where the water level is not much affected by pitching, it is always covered. But the result of adopting this system of construction is that the boiler holds an extra half-ton of water. Messrs. Thornycroft's engines are speeded higher than Messrs. Yarrow's, the pitch of the screws being finer; and this we hold to be objectionable. Nothing can exceed the skill with which the Thornycroft engines have been designed and made; but facts are too strong for them and the advocates of high-speed engines. Those who hold that we may yet have 40-knot passenger steamers may draw an instructive lesson from the torpedo-boat race of May, 1887. The consolatory feature of the whole affair is that the boats of Messrs. Yarrow and Mr. White did their work without a hitch or difficulty of any kind, and it is not to be supposed that their engine-room staffs were better than those of the Thornycroft boats.

The Traffic of the Suez Canal.

(From the London *Engineering*.)

An official return just issued by the Suez Canal Company shows such a diminution of traffic to and from the East by this route, that it will be interesting to consider the conditions which may be deemed to be operative in causing the falling off. Before attempting to do this, however, it will be desirable to quote the leading figures of the return. That these are very highly suggestive will, we think, be generally admitted; and if the considerations we can advance possess weight, there would appear to be a necessity for the company to reconsider the scale of dues, or to take such other steps as may tend to mitigate the effects of the competition which, as it seems to us, is causing and is likely, unless checked, still further to cause, much loss to the revenue of the company. The return demonstrates that during last year, as compared with that previous to it, there was a considerable falling-off in tonnage passing through the canal, and consequently an equivalent reduction in the transit receipts. The number of vessels was less by 524, the net tonnage showed a decrease of 568,097 tons, and the transit receipts a decrease of 5,680,049 francs, the same rate of dues being levied in both years. The transit receipts for 1884 amounted to 62,378,115*f.*; for 1885, to 62,207,439*f.*; and for 1886, to 56,527,390*f.* Thus for two consecutive years there has been an annual decrease which, although but trifling during the first of them, became very marked and serious during the second.

It would scarcely seem warrantable to presume that this decrease is to be attributed to any reduction in the general volume of eastern trade. Indeed the returns from our colonies in the East, as well as those from all countries with which Europeans carry on trade in that hemisphere, go to prove the contrary. As many vessels, if not more, left European ports for the eastward during 1886 as did so during 1884, while their aggregate tonnage was larger in the later year. There must therefore, it would seem, have been a divergence of route adopted, and it must be of interest to determine the causes which have led to that adoption. Now there is but one alternative route to that by the Suez Canal, and that is by the Cape of Good Hope. If there is any degree of parity in the bulk of the trade from European ports during 1886 when compared with 1884, and the Suez Canal returns show that it is not securing its former proportion of that bulk, it must follow of course that the long sea route is obtaining the increased balance of the traffic. It is a fact worth noting that the decreased figures which represent the Suez Canal traffic occur simultaneously with, and bear some relative proportion to, the advance made with the triple-compound engine. It was only during 1884 that this system received any extended trial, and during 1885 it had very considerable extension. But during last year, the results of the two previous years having fully demonstrated the economy of triple expansion, every steamship owner who was in a position to do so hastened to adopt it, a very large number of existing vessels having their engines modified, while but comparatively few new steamers were launched the engines of which were not on the new principle.

The very important saving of coal effected by this change has tended greatly, we should say, towards increasing the flow of our eastern trade *via* the Cape of Good Hope. Steamers bound for Australia and the eastern ports generally have, with but few exceptions, hitherto been obliged to call in at the Cape to fill up with coal. A call of that kind is at no time without expense, and it of course entails delay, which further adds to the cost of the voyage. Then, again, the necessity

prevents the ships from following the quickest course, which lies some 300 to 400 miles south of the Cape. These delays and cost are avoided in the case of the steamers which are capable of steaming their entire journey without putting in for coal; and it may be said, we think, that this advantage has perhaps been secured to the majority of our steamships by the introduction of the triple-expansion engine. There seems to be a parallelism of occurrence between the adoption of engines of that type and the reduction in the traffic of the Suez Canal, and the fact cannot but be noteworthy when considering the causes operating towards that reduction. Now, proceeding further upon this basis, we find, if our argument has any material degree of soundness, that the cost of working steamships by the Cape route has been reduced by the several savings above mentioned, while that route is quite on a parity in respect of coal-saving with steamers which adopt that by the Suez Canal. From this we may deduce that the fees charged for transit by the Canal are so high as to now outbalance the advantages it offers of a lesser mileage. It is cheaper, under the modified conditions which have become established during the last three years, to send a steamer by the long sea route than to send it by the shorter passage, weighted as the latter is with the heavy fees charged for passage through the canal; and we may predict, if such a conclusion may be said to be established, that we shall, unless steps are taken which may check such a result, see the tonnage using the Suez route still further annually decreasing. This, as it appears to us, can only be stayed by the reduction of the transit fees to the point where the balance of economy may be re-established in favor of the shorter passage. The fees on a 3,000-ton ship now represent the cost of nearly that weight of coal in England.

The cause we have stated must prove operative in another wav in inclining the balance of advantage towards the Cape route. Everything which brings the duration of the two journeys more nearly level will induce a preference by passengers for the latter method of reaching their destination. By the Cape they avoid the great heat of the Red Sea, so much dreaded by a large proportion of them, and the curiosity to see the numerous places at which our mail steamers stop on their voyages palls after one or two experiences. Both our passenger and cargo traffic may therefore be expected to become more and more diverted from the Canal route as high speed can be attained economically by the ocean route, and it behooves the Suez Canal Directors to take the fact into serious consideration.

We note by the return under reference, that Great Britain, during the year just passed, owned 77 per cent. of the whole tonnage using the canal. France had 8.25 per cent., Holland 4 per cent., and Germany 3.69 per cent.

The Development of the Compound Engine and the Probable Limit of Steam Pressure in Marine Engines and Boilers.

[Paper read before the American Society of Mechanical Engineers, by Charles E. Emery, New York.]

FIFTY years ago, when steam navigation was in its infancy, the steam pressure employed in marine engines was as low as 5 to 10 lbs., but as boiler construction improved a rapid increase took place to 20 and 25 lbs., until finally a sort of standstill, at a maximum of about 40 lbs., was established for a series of years. This pressure was considered so high that compound engines were constructed in which to use it. Some notable examples running on the west coast of South America were familiar to marine engineers some 20 years ago, and curiously enough the reports which came from those engines corresponded closely with the reports from modern engines of certainly better economy, in that it was claimed that the power was obtained with the consumption of 1½ lbs. of coal per indicated horse-power per hour. Higher pressures were in vogue on inland waters almost from the commencement of steam navigation on the same, but were introduced much more slowly on sea-going steamers. As improvements in the mechanical arts progressed, it was found that steam boilers could be safely constructed to carry higher pressures, and steam machinery for using steam at a pressure of 60 lbs. and more was made from time to time. Engines of the compound type were made at an early date but did not at first find much favor, and it was not until about the year 1870 that this engine was what may be called reintroduced and established as the marine engine of the future. The initial successes of this period were doubtless made by various constructors in Great Britain, the firm of Elder & Co. being probably in the lead. Mr. Thomas W. Lay, at about the same time, established a certain form of engine of this class on the Great Lakes. The writer also, through opportunities given as Consulting Engineer of the U. S. Coast Survey and Revenue Marine, took an active part in developing the system on the smaller government vessels—and the information thus obtained, together with that which could be procured from abroad, was utilized by the United States naval officers in designs for compound engines for vessels of war.

Meanwhile, the "doubting Thomases" among marine engineers claimed that just as good results could be obtained with single engines of long stroke, and a number of vessels were built to prove this theory, many of which did very well. The practical work of the compound engines in this country soon, however, had the effect of converting the most earnest advocates of expansion in a single cylinder. Without mentioning names it may be said that one after another the older engineers succumbed to the inevitable, and now the writer does not know of a single one, or a single firm, that adheres to former opinions and prejudices. To-day there are numbers of ocean steamers, both small and large, running with steam pressures as high as 160 lbs. to the square inch. The steam is used in triple-expansion engines, and the advocates of the system claim as great economy in the change from double to triple expansion as was originally claimed in that from simple engines to the ordinary compound engines. Undoubtedly overstatements are made as great as those formerly made in relation to the ordinary compound engine. The results with the latter should of course have been compared only with those from engines operating with the same steam pressure and under the best conditions for economy at that pressure; whereas they were frequently compared with those from low-pressure engines of obsolete type. The performance of the triple-compound engines are not only not being compared with those of compound engines operating at the same pressure, but comparisons have been made with the results obtained with engines which have been allowed to run down, and in cases where the boilers have deteriorated so that the pressure originally intended is not maintained.

With the view of settling various questions of this kind in relation to the original compound engine a series of experiments were made in the years 1874 and 1875, under the general direction of Chief Engineer Charles H. Loring, U. S. Navy, representing the Navy Department, and the writer, representing the Treasury Department, with the machinery of various revenue steamers, designed by the writer, one having a compound engine, another a high-pressure condensing engine, another a similar engine with a jacket, and another with a low-pressure engine.

These experiments showed that at the pressure employed, viz.: 70 lbs., the gain due to compounding was only 12 to 15 per cent. as compared with using the steam with an equal degree of expansion in a single cylinder. Official reports of these experiments were made to the Navy and Treasury departments and the results discussed by the writer in several journals. Abstracts of the reports were also made by various periodicals and embodied in the current literature on the subject. In the discussion, the writer stated that the average economy of compound engines was doubtless nearer 25 per cent. than 12 to 15, on account of mechanical difficulties incident to keeping in order single engines working at a high degree of expansion and the liability of the engineer to reduce the steam pressure and follow a little further in the stroke to relieve the strains on his joints and all the working parts.

of the engine and save himself work. The same difficulty was experienced with the first compound engines, and is supposed to be one reason why the Elders, in their original engines, set the main valves to cut-off with full link at about one-half the stroke on the high-pressure cylinder, so that the engineer could only control the cut-off with the independent gear within that limit. In the above experiments a horse-power was obtained in the compound engine of the U. S. Revenue steamer *Rush* for 18.38 lbs. of feed-water per hour, the steam pressure being nearly 70 lbs. Now, if the steam supplied to the engine in this case had been generated at about 160 lbs. pressure, and used to operate another piston until its pressure was reduced to that actually used in the high-pressure cylinder of the *Rush*, there would, on the basis that 80 per cent. of the total feed-water was utilized in such first expansion, have been obtained about 40 lbs. mean pressure and 21.3 per cent. additional work, and the cost of the horse-power would have been reduced to 15.15 lbs. of feed-water per hour, which would have required, for an evaporation of 8 lbs. of water per pound of coal, 1.89 lbs. of coal per H. P. per hour. In average practice, it is believed that the evaporation would frequently be nearer 7½ lbs. than 8, which would increase the coal consumed to, in round numbers, 2 lbs. of coal per indicated H. P. per hour.

This indirect method of procedure probably gives about the average performance to be expected under actual conditions in modern triple-expansion engines of moderate size. A better performance is claimed and undoubtedly is obtained under experimental conditions and in the larger ocean steamers. It is thought that further gain must be looked for in the performance of the boiler, as it is not believed that very much better results than 15 lbs. of water per indicated H. P. per hour may be expected.

A clear gain, however, of upward of 20 per cent. is very important, and by the same method of reasoning, it would appear that steam of still higher pressure might be expanded in still another cylinder and used again and again with economy. This corresponds with the conclusion from different premises stated in another paper presented with this, on the subject of "Cylinder Condensation, and the Reduction of the same by the use of the Compound Engine."

On the above basis, the limit of pressure would probably be fixed only by the capacity of the materials forming the steam cylinders and valve-chests to resist the higher tensions and higher temperatures. It is probable that no material better than cast-iron will be found for steam-engine cylinders, and this is made sufficiently dense to resist hydraulic pressure of several thousand pounds. Difficulty is, however, experienced in carrying pressures as high as 300 lbs. with ordinary castings, and if the steam pressure were to be increased to or beyond that point more care would be necessary in selecting and manipulating the metal and molds.

A steam pressure of upward of 300 lbs. was successfully carried on a small steamer called the *Anthracite*, which was built in England on the so-called Perkins high-pressure system, and visited this country in 1880 to demonstrate that high pressures could be safely and efficiently utilized to furnish motive power on an ocean voyage. Her machinery was tested by a board of naval officers in New York. With an average steam pressure of 316.5 lbs., expanded 25.7 times in triple-expansion engines, there was required 21.64 lbs. of feed-water per hour per indicated H. P. The engines were small, the aggregate indicated H. P. developed being but 67.7. Still the cost was quite high, no lower, in fact, than has been obtained in exceptional cases with good condensing engines, and about what ought to have been expected with an ordinary compound engine using a steam pressure no higher than 80 lbs. The same engine, tested in England by Mr. Bramwell, furnished a horse-power for 17.8 lbs. feed-water per hour, the water level being then carried lower, so that the steam was superheated considerably. The superheating of the steam at these high pressures is not desirable in practical work on account of difficulty with the packings and lubricant. In the Bidwell experiments in Boston with superheated steam, it was considered that 450 deg. was the highest temperature which should be permitted. Proper precautions would indicate that even this temperature should not be allowed in sea-going engines involving so many responsibilities. The temperature of steam of 300 lbs. pressure is about 420 deg., which, in the opinion of the writer, is as high as can be carried satisfactorily in average practice either in sea or land. It seems certain that the highest steam pressure admissible would be limited by the temperature rather than by other conditions. In some of the marine engines using steam at 160 lbs. pressure, it is found that there is a sufficient precipitation of water to permit the use of oil to be dispensed with after the engines are fairly started from port. The temperature due to this pressure is but about 370 deg. In the *Anthracite*, designed for a higher pressure, with some superheating, all the packings were made of a metal adapted to obviate the necessity of using oil, and it is believed that, if the steam be kept dry so as to secure economy, that a pressure even of 300 lbs. will not be carried in practice without the use of some device of this character; and as any specialty always acts to limit general application, a less pressure will probably be generally adopted.

It is considered by the writer that the proper limit of pressure has already been reached, if not exceeded, for the type of boiler used in large ocean steamers. Cylindrical boiler shells 12 ft. and upward in diameter, and 1⅛ to 1¼ in. thick are not recommended, although used in practice. To limit the thickness even to the figures named it is necessary to use steel; and to procure even this of sufficient tensile strength, it is necessary, for such heavy plates, to use steel comparatively high in carbon, which is treacherous under ordinary manipulation. Not a plate of it should be used without annealing after every mechanical operation performed upon it. In fact the whole boiler ought to be annealed after the plates have been riveted together in order to overcome the injurious effects due to local strains produced in working it, but this is impracticable. Of course, boilers are made as heavy as this and but few fail, but the business cannot be considered on a safe and reliable basis so long as *any* fail.

As these are notes for discussion, it is considered well to state as an opinion that, since so many manufacturers have gone into the steel business, steel can no longer be considered in a commercial sense better than iron. The element of competition brings out steel which is altogether unfitted for boiler plates. Some boiler-makers recommend their customers not to use steel, and it is only when it is carefully inspected to ascertain its quality before being made up, and also carefully inspected while the boiler is being constructed, that the steel boiler can be relied upon. It is so much more homogeneous and in every way desirable when the material is right that there is no danger of every one going back to iron; at the same time, the steel industry is bound to have its ups and downs on account of the improper material furnished by many of the manufacturers. The new ones are not entirely to blame, as some of the older ones send out inferior material under the spur of competition. It may be proper to say that no steel should be used for boilers, unless it be properly inspected or furnished by a firm which is known to keep up its reputation, and to send out nothing but what is suitable for the purpose.

The type of boiler used in the most modern men-of-war is of the locomotive type and has a smaller shell than the ordinary merchant marine boiler, and hence plates of proper thickness can be obtained without using steel so high in carbon. It would seem better to retain for these boilers the sizes now in vogue, rather than make larger ones requiring thicker plates, and also to retain substantially the thickness now in vogue, rather than to carry higher pressures requiring plates so much thicker as to necessitate the use of steel unusually high in carbon.

It is the opinion of the writer that boilers to carry the high pressures under consideration should be entirely without shells, except those of necessary separating drums with comparatively small diameters. On this system there will be no difficulty in carrying pressures as high as 400 or

500 lbs. or more if the difficulties referred to in the way of lubrication, etc., for cylinders could be overcome to permit them. Sectional boilers are so well worked out for use on land, and there has been such measure of success even in sea-going vessels, that it seems safe to conclude that the use of higher steam pressures need not be limited by difficulties in the construction of the boiler.

There is no reason why pressures as high as those in use on the western rivers, viz.: from 180 as high as 200 lbs., should not be adopted in general practice to secure economy of fuel, and the considerations above expressed in relation to the lubrication, etc., indicate that the pressure may be increased to, or nearly to, 300 lbs., when commercial and economical considerations demand such a pressure. It is probable that for pressures exceeding 200 lbs, *quadruple*-expansion engines should be used. The experiments with the *Anthracite* appear to sustain such an opinion. The writer has not seen a record of actual experiments, giving quantitative results with triple-expansion engines other than those of the *Anthracite*, though much information of a comparative nature is available which is subject to the objections first above indicated.

Accidents to Trainmen.

AT the annual convention of the Master Car-Builders' Association in Minneapolis, the following report was presented by Mr. M. N. Forney, from the Committee on Accidents to Trainmen:

At each annual convention of this Association for a number of years past a committee has been appointed to make a report on accidents to trainmen. At successive meetings various excuses have been made by such committees for not presenting reports on this important subject. Within a few weeks of the date of the meeting of this annual convention, the third member of the committee had not heard from either of the two other members of the committee. As it seemed to him it would, or should, be a cause of regret if no report whatever was made on so important a subject, he determined to prepare a paper on his own responsibility in the very limited time which the duties of his official position left at his disposal. This paper or report is therefore the work of a minority of one. After it was written it was submitted to another member of the Committee, so that it has the sanction of a majority of the Committee. Owing to the haste with which it has been prepared, it does not assume to be the result of an exhaustive or adequate study of the subject, but the facts it contains and the inferences therefrom are presented to the Association, with the hope that they will excite a discussion which will suggest the direction that a more complete investigation of the subject should take in the preparation of a future report.

The last reports of the Railroad Commissioners of the States of Massachusetts, New York and Michigan show that during the year previous there were 217 railroad employés killed and 1,226 injured in these three States. From these same reports and from *Poor's Manual* we find that there were 4,856 locomotives in the railroads of these three States, and in the whole of the United States there were 25,937 locomotives. Now it may fairly be assumed that locomotives in other parts of the country do about the same amount of work that they do in the States named. If, then, 217 employés are killed and 1,226 injured while 4,856 locomotives are doing a year's work, it may be inferred, by a deduction of the single rule of three, that while 25,937 locomotives in all parts of the country are doing their work, 1,426 employés are killed and 6,548 are injured. This, then, indicates approximately the annual sacrifice of life and limb of railroad employés in this country. The calculation makes no pretense to giving accurate or precise figures, but it indicates with terrible emphasis what an awful amount of suffering, pain and anguish is due to this cause.

This is perhaps not an occasion for being pathetic, but it certainly is the duty of those who compose this Association to do all in their power to lessen the risks to which those who operate railroads are exposed. With this end in view, let us inquire what are the chief causes of injury to trainmen.

From the reports which contain the figures quoted, the following classification of the causes to which the accidents are due can be made.

STATE.	Coupling or uncoupling cars.		Train Accidents.		Falling from Train or Engine.		Various Causes.		Total.		Number of Locomotives.
	Killed.	Injur'd.	Killed.	Injur'd.	Killed.	Injur'd.	Killed.	Injur'd.	Killed.	Injur'd.	
Massachusetts	2	105	8	18	17	38	36	50	63	211	1445
New York	23	365	31	97	40	152	65	174	159	788	2583
Michigan	10	104	3	21	16	37	16	65	45	227	828
Total..	35	574	42	136	73	227	117	289	267	1226	4856

In the following table the percentage which the number killed and injured, under each of the headings, bears to the total, has been calculated:

	Killed. *Per cent.*	Injured. *Per cent.*
Coupling or uncoupling cars	13.1	46.8
From accidents	15.7	11.1
Falling from trains or engines	27.4	18.5
Various causes	43.8	23.6
	100.0	100.0

This shows that nearly one-half of the injuries are from coupling cars, but that the percentage of fatal accidents from that cause is only 13.1, whereas 27.4 per cent., or more than twice as many, are killed by falling from trains and engines, but only 18.5 per cent. of the injuries are due to that cause. The large number of employés killed and injured by coupling cars, and by falling from trains will, or should naturally lead the members of this Association to inquire how this mortality and mutilation may be reduced, as the construction of cars has much to do with the risks to which the employés are exposed. Public clamor and indignation at the great sacrifice of life and limb from coupling cars, has led to the inference that it would be very largely diminished if automatic couplers were generally adopted, and much of the time of this Association has of late years been devoted to the consideration and investigation of the merits of various automatic couplers. Laws compelling the adoption of automatic couplers have been hastily enacted in various States, apparently without serious consideration or investigation of the question whether their use would materially lessen the number of coupling accidents. Owing to the large number and variety of self-couplers which have been put into use of late years, the members of this Association should now be able to know whether they lessen or increase the danger to employés.

The important question whether the risk and danger in coupling cars would not be reduced more by improvement and uniformity of non-automatic draw-gear, than by the adoption of a variety of self-couplers or the attempt to adopt one or very few kinds, is worthy of consideration and discussion by this Association. Many experienced railroad men are of the opinion that automatic couplers will not reduce the danger and the number of accidents from coupling cars. There can be no doubt that the form and construction of non-automatic draw-gear can be improved and reduced to uniformity, and that if this was done and if the standards for their height and for the dimensions for dead-blocks recommended by this Association were generally adopted, and if obvious safe-guards such as handles on the ends of cars, were generally provided, that coupling cars would be much less dangerous than it is now. The difficulties in the way of the adoption and the use of any one or even a few kinds of couplers are so great as to appear to be almost insurmountable at present. There are so many conflicting interests arrayed against each other, that at present it seems hopeless to reconcile them, and even if there were no such conflict, it does not seem that any self-couplers which could now be selected would be sure to lessen the risk of coupling cars, whereas it is certain that the improvement and reduction

to uniformity of non-automatic draw-gear would make the occupation of the brakeman less dangerous than it now is.

Furthermore, it is very desirable that the draw-gear and the ends of cars should be uniform in construction if an automatic coupler is adopted, so that if the efforts of this Association should be directed to the improvement of the non-automatic draw-gear, it would first be certain to diminish the risk of coupling cars, and next such a change will make the adoption of automatic couplers easier in the future.

Regarding accidents caused by trainmen falling from trains, the following remarks of a highly esteemed member of this Association, Mr. J. W. Marden, may be quoted. In a letter dated June 11, he says:

"I would urge upon all the members the importance of having proper appliances on all of our cars for the protection of trainmen, and having them kept in good condition. We were receiving so many cars with running-boards defective, ladder-rounds, grab-irons, steps, etc., gone, that I sent out a circular letter to different roads asking them if they would approve bills for repairs to such appliances; not that it was according to the rules, but that it was what I considered a proper charge to be made.

"We have repaired running-boards, grab-irons, handles, etc., to as high as 300 foreign cars a month at North Adams, which shows that these appliances are not watched and repaired as they should be. I am free to admit that our own cars are not up to the standard that they should be, and yet we are making every effort to bring them up, and would be glad to approve any bills for repairs of the safety appliances for trainmen."

Mr. Marden's remarks indicate that what is needed is more rigid inspection of cars. The author of this paper is not prepared to recommend any improvement in the appliances for the protection of trainmen from this class of accidents referred to, but he has no doubt that the experience of the members of this Association would enable them to point out the defects and suggest improvements in the steps, handles, railings, etc., of the cars now in use. There seems to be no good reason why a standard should not be adopted for the construction, location and proportion of such parts of cars. If uniformity could be secured there certainly would be less danger to trainmen than there is now, when nearly every car in a train is different from every other car.

The aim of this paper is to present the subject in such a way as will call out discussion, and which, as mentioned before, will indicate the direction that the inquiries of the Committee should take for a future report to guide the action of the Association.

Automatic Car-Couplers.

THE Committee on Automatic Couplers for Freight Cars presented a report to the Master Car-Builders' Convention at Minneapolis which is long and of so much value, that we regret that we can find space to give only the conclusion. The report is signed by Messrs. B. K. Verbryck, F. D. Adams, John W. Cloud, R. C. Blackall, E. W. Grieves, John S. Lentz, John Kirby, and Edward B. Wall, and their conclusions are as follows:

CONCLUSIONS.

We have now therefore reached the point in the solution of this problem, where we can say that the question which presented itself at this time last year, with reference to the value of slack, has been decided, and that consequently the choice for this Association to make is again narrowed down by a great step from between the loose link and the hooks coupling vertically, to the best subtypes of the hooks. * * * *

The Janney type of coupler, including the Janney, Dowling, Thurmond, and we think ultimately the Barnes and Hien, is the type to which the evolution of the subject has brought us; it affords a close coupling with spring slack; it makes it possible to use power train-brakes; it already includes several couplers and opens the door to more, so that no railroad company is restricted to purchasing from one manufacturer; it incorporates more of the practical requirements of a perfect automatic train connection than any other type or form of coupling. It is not a new, unknown and untried coupler; it has been used in the Janney form very extensively on some of our largest roads in the North and West, and in the Thurmond form in the South. Its most serious defect is in strength, and the question that now presents itself is, "Can this defect be remedied?" We consider that it can, and the further development of the problem must be in this direction, and what we say here on the subject of strength is applicable to all forms of couplers, no matter of what type. This development can be accomplished by following three paths:

First: Increase the dimensions.

Second: Improve the character of the material.

Third: Protect the coupler by deadwoods, or, better still, spring buffers. * * * *

Your Committee feels that the status of the problem at the present time, as here stated, warrants them in making the recommendation that this Association recommend, as a standard form of coupling, the Janney type of coupler; that the Association procure one of the present make of Janney coupler, selection being made by a committee appointed for that purpose, and then all other forms of couplers that will automatically couple to and with this coupler under all conditions of service are to be considered as within the Janney type and conforming to the standard of this Association. Your Committee trust that you will see fit to submit this recommendation to letter ballot; we make it with a full appreciation of the gravity of the situation. We have, as our past and present reports, we trust, will show, approached this conclusion with great care and consideration, and we believe that no other conclusion would be in harmony with the facts.

Our study has been based purely on the mechanical features of the problem, although we have not hesitated to consider and point out incidental advantages, not mechanical, that would result from the adoption of the Janney type. We believe that the office of this Association, and of its members, is with the mechanical department of railroading, and that what our railroads want and look to us for, is a statement of what type of coupler best fulfills the mechanical condition of a perfect train connection; when we have done this we have performed our duty, and to our superior officers belongs the question of negotiation for the use of couplers. If you approve the recommendation of your Committee, you give the railroads the type of coupler which meets more of the requisites than any other type or form. It is a type capable of fundamental duplication, already duplicated successfully, so that there is now, and we believe there will be still more opportunity for selection between several different forms of the same type.

There is an urgent necessity that the Association should act at this time, either in the line that your Committee has recommended, or in some other. Railroads have reached a point where there is an absolute need for an automatic train-coupler; it is vividly apparent that a coupler must be introduced to save the life and limb of the employes; to decrease the cost of operation by enabling the use of power train-brakes; to do away with the shocks of stopping and starting, and to eliminate the damage of bunching trains in sags and hollows.

The public demands it; the safety of the trainmen demands it, and the economical operation of railroads demands it already. Already, several corporations are acting, and more, some of them very large, are acting this year; the urgency is great and will not brook delay. If we do not agree upon some course, we will be reprehensible, for it is only by this Association that uniformity can be established, in order that all of the lives and limbs which it is possible to save will be saved; that all of the benefits in operation that it is possible to achieve will be achieved. If we do not secure this uniformity, who will be responsible for the extra risk which comes to train men when two odd couplers on a home and foreign car are brought in conjunction? Who will be responsible for the extra cost of operation that such a condition will entail? This Association. The fruit is now ripe, and if

you do not pick it it will be spoiled, for next year, numberless complications, arising from the introduction of miscellaneous couplers, will lose this Association in a mesh from which it will never be able to rise, and our opportunity to serve our fellow-men and our companies will be irrevocably lost.

In view of the facts already mentioned, that the best type of couplers is still undergoing development in matters of strength and simplicity, and that many railroads are not ready to adopt it until it is better perfected, your Committee would further recommend the continuance or use of the Marks, the Ames and the McKeen couplers as the best representatives of the loose coupler.

Freight-Train Brakes.

At the convention of the Master Car-Builders' Association in Minneapolis, the Committee on Freight-Train Brakes presented an elaborate report giving the history of the brake tests at Burlington last year and of the tests in May of this year. An interesting part of the report, on Resistance of Trains, is given on another page. Of the rest we have only space for some of the conclusions reached by the Committee, which are given below:

ELECTRICAL APPARATUS.

It seems to us the whole question of the application of electricity to railroad braking resolves itself into three important questions:

First, can a valve mechanism be made operative by electricity, which shall be permanent and practical for railroad service, not having parts too sensitive or of too fine adjustment? We think it can. The valve construction, as shown by Mr. Carpenter, the same which he used in these trials, is certainly not more delicate and complicated than that of the well-known Westinghouse triple valve.

Secondly, can the electric conductor for working these valves be so insulated and protected as to avoid short circuits and other injuries? We think it can, by running the wires inside of the air pipes, where they are as little liable to derangement and injury, and become as permanent and certain in their functions, as any other feature of the brake mechanism. In all the electric brakes shown the wires are laid inside the air-hose couplings, where they are fully protected and their connections are made from car to car easily and certainly, so that this important point is so far settled as to require no further explanation.

The remaining point is the source of the electro-motive force.

Of the different means employed by the companies represented, the secondary battery appears the most reliable, giving a constant current all the time until discharged, recharging being a simple process which can be so methodically and practically arranged as not to interfere with brake service nor add materially to the expense.

If brakes worked by electricity are to come into general use it is probable that both battery and dynamo will give way to the magneto generator, being a small machine about 18 in. square, having an easily turned crank which instantly develops the electro-motive force required, so that a turn of the crank will actually apply or release the brake. One of these machines was shown us in operation upon an engine and tender brake. This apparatus may solve a most important point connected with the application of electricity to railroad brakes, in as much as it renders the apparatus on the locomotive independent of any special stations or roundhouses or any stated period when a battery, if used, would have to be recharged.

We believe from what we have seen at the Burlington brake tests, and from close personal examination of the several electrical arrangements for braking, that electricity, properly devised and managed, may be made a valuable auxiliary to actual power brakes on long trains, and their efficiency considerably increased thereby.

GENERAL CONCLUSIONS.

At the conclusion of the 1886 trials the Committee felt that to sum up any results in the face of so large a field for improvement could not but be unsatisfactory, and while a wonderful advance has been made in the brake problem, as will be seen by a comparison of the stops of each year, the 1887 tests apparently leave the field for improvement open as wide as in 1886.

The Widdifield & Button and the Rote buffer brakes, hopeful over the shocks given by the atmospheric brakes, are fitting up or have fitted trains to pursue their investigations; the Westinghouse Brake Company, loath to accept the teachings of 1887, is making changes in valves and piping by which it hopes to make short 50-car emergency stops without objectionable shocks and without the aid of electricity; the American Brake Company, convinced that buffer brakes cannot compete with the continuous, is about testing a 50-car train fitted with a new electric atmospheric brake. While we are not prepared to make any definite recommendation at this writing as to what freight-train brake should generally be adopted, our present information, derived from the recent tests, points to two conclusions:

First, that the best type of brake for long freight trains is one operated by air, and in which the valves are actuated by electricity.

Second, that this type of brake possesses four distinct advantages.

(*a*) It stops the train in the shortest possible distance.

(*b*) It abolishes shocks and their attending damages to equipment.

(*c*) It releases instantaneously.

(*d*) It can be graduated perfectly. The further question as to whether electricity is a sufficiently reliable element to use in freight-train service is one that can only be determined by experiment, but we think the benefits derived from electricity are so manifest that the experiment is well worth trying.

In view of the foregoing, and of the improvements that the buffer and atmospheric brakes are making, your Committee recommends that the subject of Automatic Freight-Train Brakes be continued for further investigation.

Manufacturing Notes.

Riehlé Brothers, in Philadelphia, have recently received orders for a number of large scales and testing machines for various parties. These include a cement-testing machine for Princeton College and a spring-testing machine to go to London, England.

The Lobdell Car Wheel Company recently purchased the mineral rights on a tract of land containing 400 acres at Max Meadows, Wythe County, Va., for $1,000. Miners were put to work developing, and in a short time uncovered a load of iron ore of most excellent quality, and apparently great extent.

The Pennsylvania Bolt & Nut Company, of Lebanon, Pa., has recently added an artificial gas plant to the works. The furnace and gas producers were designed by M. V. B. Smith, Metallurgical Engineer, of Pittsburgh, and contain improvements whereby, it is said, the consumption of fuel is reduced to less than 250 pounds of Clearfield coal to the gross ton of iron heated.

The South Baltimore Car Company has been recently organized. The capacity of the works will be from 8 to 12 freight-cars per day. The location is at Curtis Bay on a branch of the Baltimore & Ohio Railroad, about 6 miles south of Baltimore, where a large tract of land has been secured. From 50 to 100 houses will be erected, to be occupied by the men and their families employed in the shops; streets will be laid out, paved and curbed by the time the works are in operation. The contract for the buildings has been let to Philip Walsh & Sons, of Baltimore; they will be completed by September, 1887. The buildings will be of frame covered with corrugated iron excepting the cupola-house and saw-mill, which are of brick with slate roofs. It is expected that the works will be in operation by October or November next. Mr. Wm. Keyser is President; E. Brent Keyser, Secretary and Treasurer; Howard Carlton, Manager.

Manufactures.

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Continued from page 276.)

CHAPTER V.

THE ENGINES.

SLIDE-VALVES.

The first slide-valves used at the Rogers Works were the ordinary *D* pattern. In 1853, Mr. Rogers adopted the Hackworth valve, fig. 165, with double exhaust-ports. This valve had about $\frac{3}{16}$ in. lap at *a a'*, and only $\frac{1}{32}$ at *b*. Consequently, the steam was not released at *a a'*, as shown in fig. 166, until the steam-port *B* was opened nearly $\frac{3}{16}$ in. wide at *b*. Then the two ports *a* and *a'* each commence to open. The exhaust was thus delayed, but when it did begin the steam escaped through both of the openings at *a a'*. The area of the exhaust opening was, therefore, doubled when the release occurred. This form of valve was used up to 1872 and applied to more than 250 engines, but its advantages did not seem to compensate for the increase in its area, which was due to the double ports.

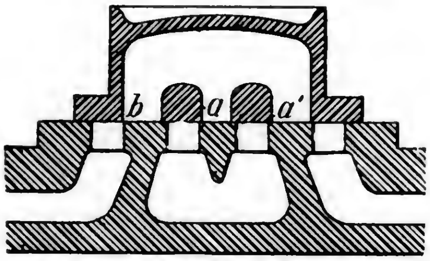


Fig. 165.

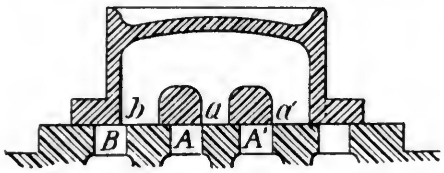


Fig. 166.

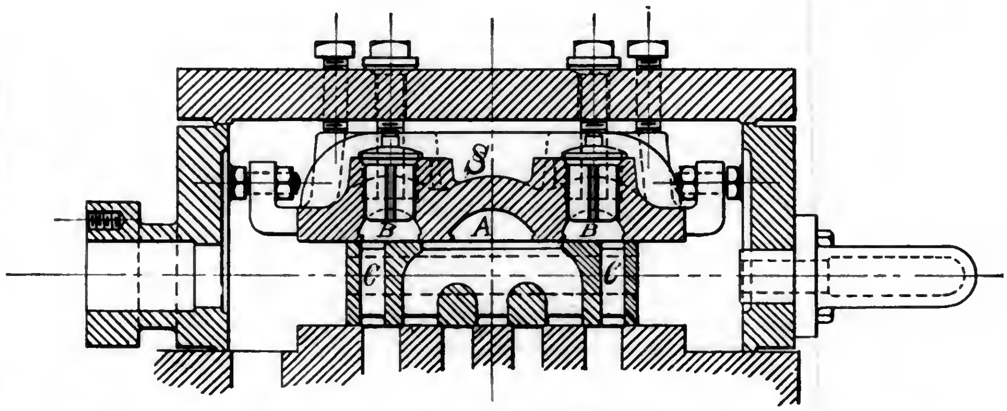


Fig. 167.

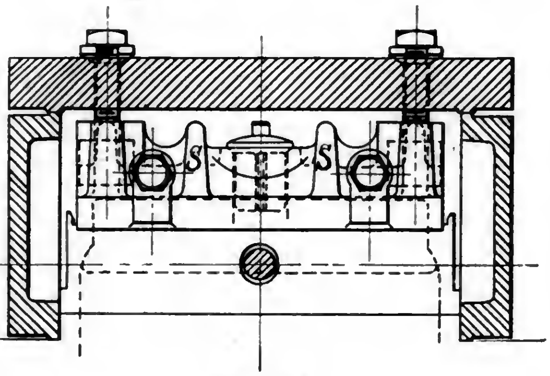


Fig. 168.

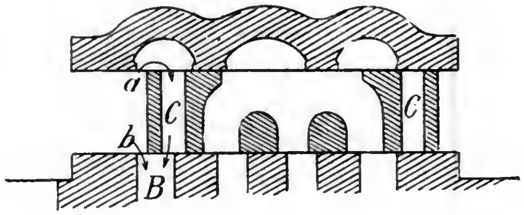


Fig. 169.

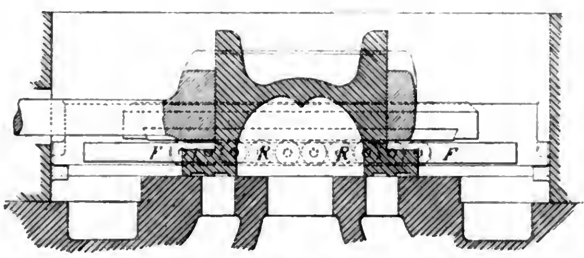


Fig. 170.

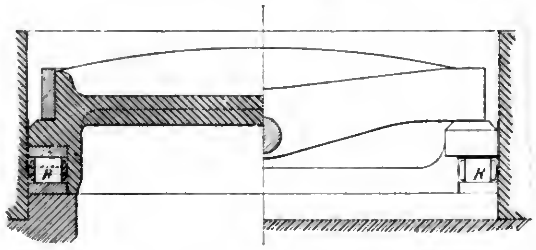


Fig. 171.

In 1864, Mr. John Gleason patented a valve which Mr. Hudson afterward modified and introduced in the form shown by figs. 167 and 168. This had a saddle, *S*, on top, the position of which was regulated by set screws, as shown. The saddle had steam openings, *B B*, and an exhaust opening, *A*, on its under side. The valve had double exhaust-ports, the same as are shown in figs. 165 and 166. In addition it had two supplementary steam passages *C C*. In the position show in fig. 169, not only was the steam-port *B* open at *b*, but there was another opening at *a* through which steam passed to the supplementary port *c*, as shown by the dart, and thence to the cylinder. The opening of the steam-ports was thus doubled during the early portion of the period of admission. A similar action occurred on the exhaust side. This valve was tried, but with rather doubtful resulting advantages.

In 1868, the Bristol roller slide-valve, shown by figs. 170 and 171, was applied to a number of engines. This valve rested on a series of rollers, *R R*, placed in each side of the valve. They were connected to a frame, *F F*, their axles or spindles having a little play in their journals. Steel plates were attached to the valve on each side, and others to the valve-seat, so that the rollers rested on the latter below, and the valve was carried by the upper plates, which in turn rested on the rollers. With careful workmanship, the pressure of the valve could be carried on the rollers, and as it wore, of course, there was little or no contact between its face and seat. These valves were quite extensively introduced, but their use has been gradually abandoned.

In 1882, two forms of the Allen valve were introduced. Figs. 172 and 173 show an Allen valve with Richardson's "balanced" or equilibrium device applied to it, and fig. 172 shows an Allen valve with extensions to increase its length, and with steam-ports to admit live steam from below into the supplementary port *S S*. The Allen valve, although an American invention, was not used on locomotives in this country to any extent until after the expiration of the patent on it. It is now extensively used, and its advantages are generally recognized.

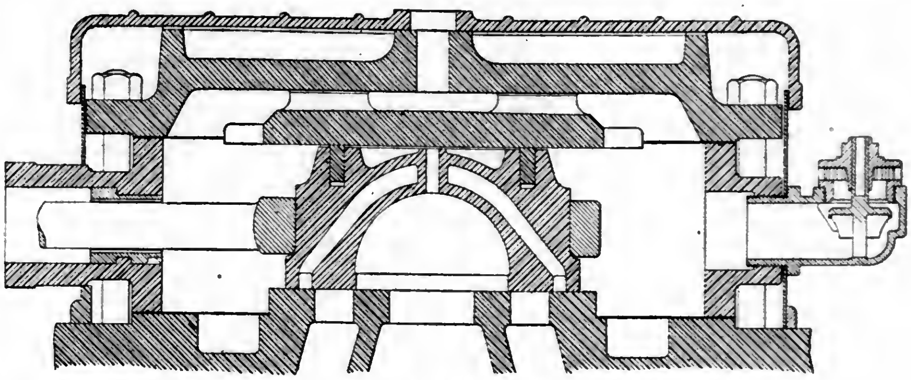


Fig. 172.

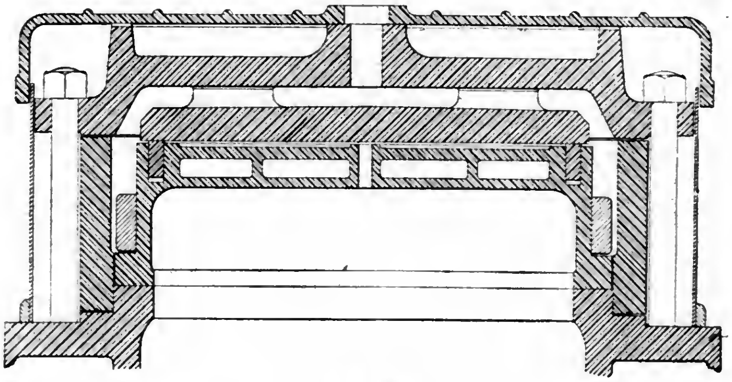


Fig. 173.

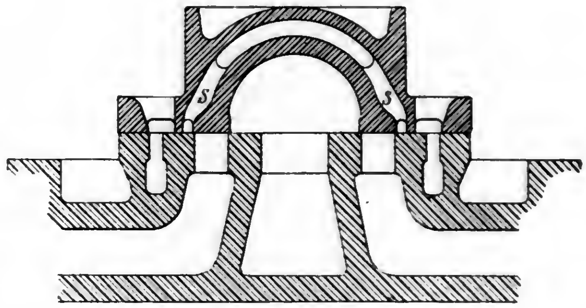


Fig. 174.

THE RUNNING GEAR.

FRAMES.

The frames used on the first locomotives built by Mr. Rogers (see figs. 12 and 14) were made of two plates, with wood fillIng between them. The journal bearings were outside the wheels, as shown in the figs. referred to.

Bury, who first introduced the hemispherical topped furnace in England, also used bar frames on some of his engines. It seems probable that his form of fire-box and method of con structing frames were simultaneously introduced here. There are no drawings extant of the early frames made at the Rogers Works, but in 1844 the form of frame shown in fig. 175 was used. It consisted, as will be seen, of a straight bar on top, with cast-iron pedestals bolted to it and braced at the bottom very much after the manner in use at present.

In 1850, wrought-iron pedestals were substituted for those

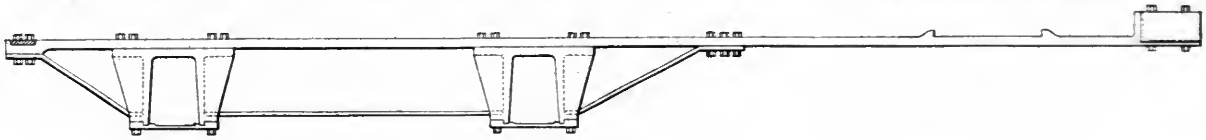


Fig. 175.

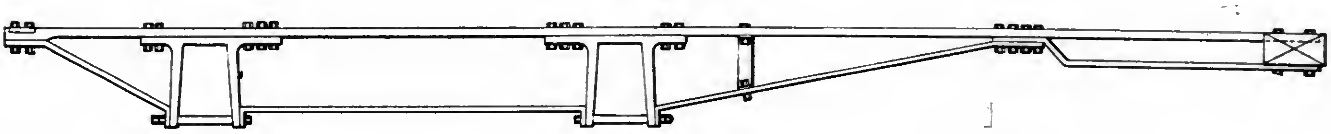


Fig. 176.

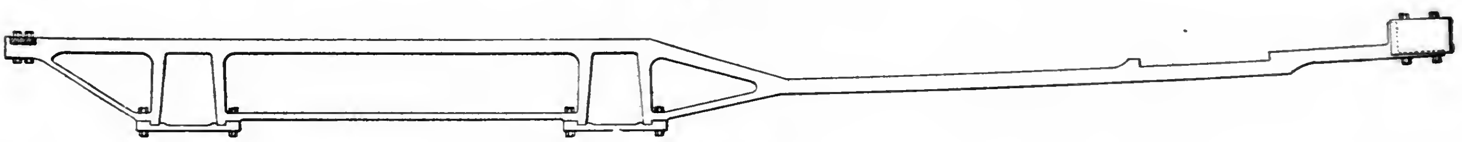


Fig. 177.

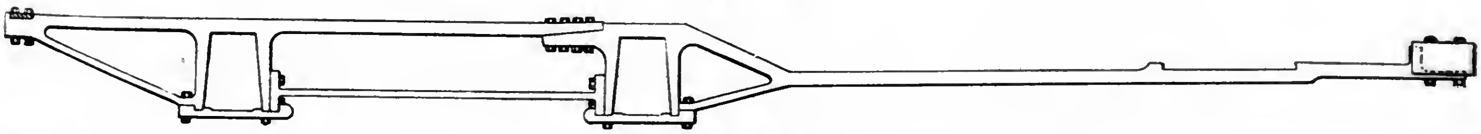


Fig. 178.

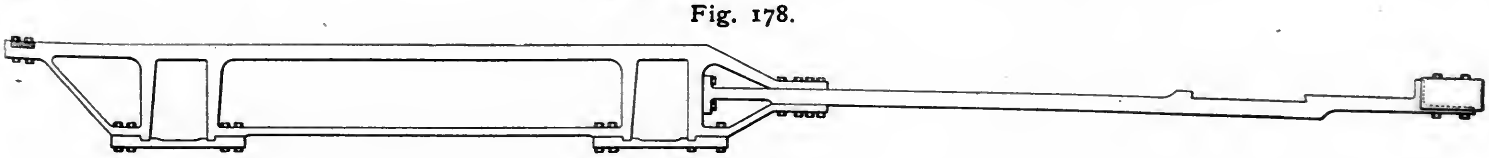


Fig. 179.

of cast-iron, as shown in fig. 176. In 1854, the whole frame was forged in one piece, as shown in fig. 177. With this form of construction some difficulty was encountered in cases of collision and other accidents to locomotives, in which either the front or the back ends of the frames were injured. It then became necessary to take down the whole frame to repair one end. This led to making the front and back ends in separate pieces and bolting them together, as shown in fig. 178. With this plan, if either end was taken down, it was necessary to remove one pair of driving-wheels. As the front part of the frame is usually injured in accidents, it was desirable to be able to take it down without removing any of the driving-wheels. The plan shown in fig. 179 was therefore adopted in 1868. In this the front end is bolted to the back end, ahead of the front pedestals, so that the front part can be removed without disturbing the driving-wheels, if it is desirable to do so. This form of construction is the one which is still used and has been very generally adopted on American locomotives.

SPRINGS AND EQUALIZING LEVERS.

Ordinary equalizing levers were used between the driving-wheels on the engine represented by fig. 18, which was built in 1845. Mr. Rogers appreciated their value, and very few, if any, engines were afterward built without using them in some form. Figs. 182 to 186 show the forms of spring and equalizing lever arrangement that were successively used for eight-wheeled American engines.

Figs. 187 and 188 represent a plan adopted for narrow-gauge engines in 1878. The purpose was to allow a wider fire-box to be used than is possible when the springs are placed alongside of it.

Fig. 189 shows the arrangement of springs used in 1880 for consolidation engines. The springs for the front axle are not shown in the engraving. Their connection with the leading truck and other applications of equalizing levers will be described further on under the head of trucks.

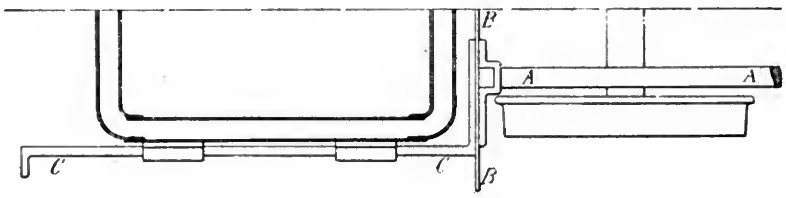


Fig. 180.

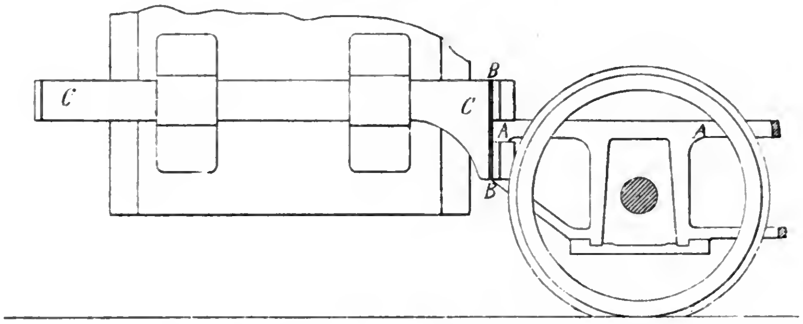


Fig. 181.

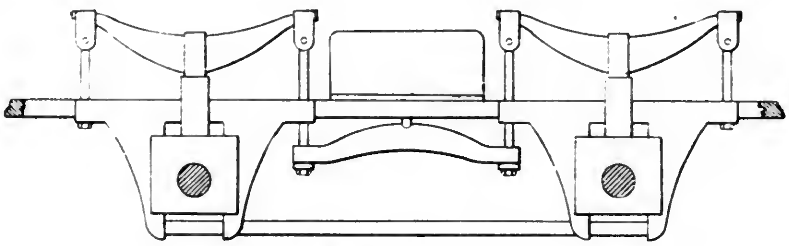


Fig. 182.—1837.

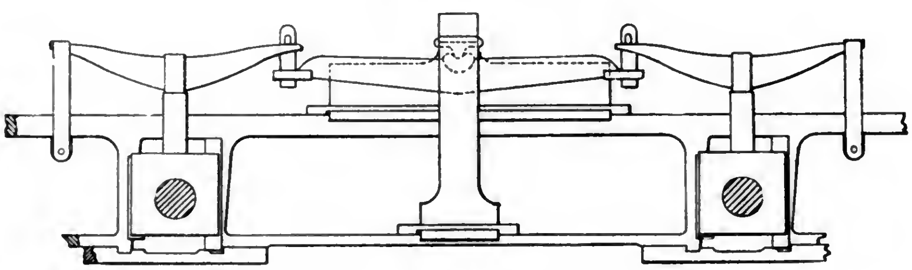


Fig. 183.—1850.

One of the difficulties in the construction of narrow-gauge engines is that there is not room enough between the frames for the fire-box, and it must, therefore, be made very narrow. To obviate this, Mr. Hudson, in 1873, designed the frames shown in figs. 180 and 181. In this plan the main frames *A A*, are placed in the usual position inside of the wheels. A cross-plate, *B B*, which projected outside of the wheels, was bolted to the back ends of the frames. Two flat-bars, *C C*, were then bolted to the cross plate, and placed far enough apart so as to give sufficient room between them for a fire-box of the width required.

DRIVING-WHEELS.

A method of constructing driving-wheels for 5 ft. gauge roads, which, it was expected, would have their gauge changed, and which would, therefore, require to have their tires brought nearer together to conform to the altered gauge, is shown in figs. 190 and 191. A projection, *P P*, was cast on the inside of the wheel-center. The tires were then set to conform to the wide gauge. When the time came to narrow it, the tires were simply moved farther in. The projection of the wheel-center which was left on the outside was then turned off, which left the wheel in proper

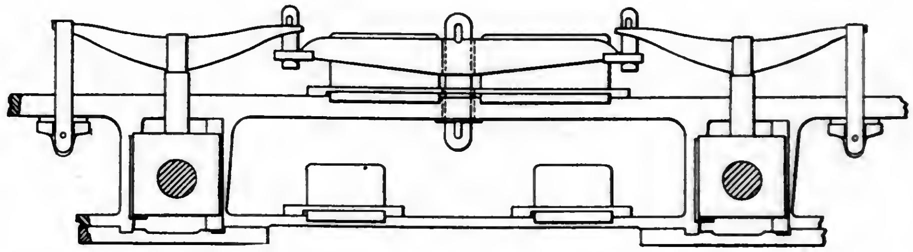


Fig. 184.—1860.

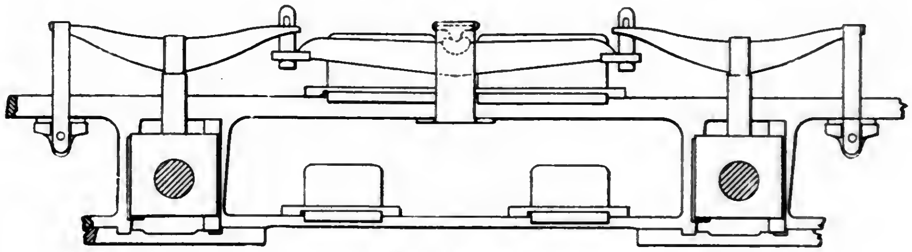


Fig. 185.—1867.

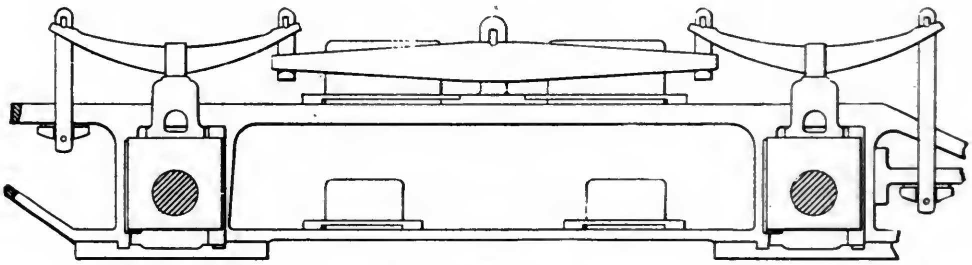
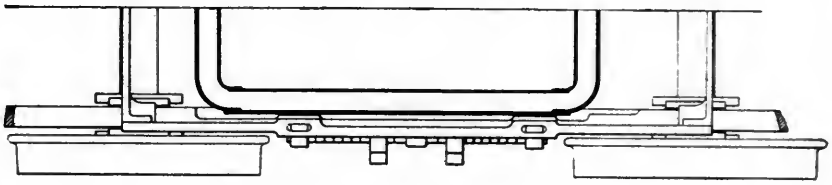


Fig. 186.—1880.

Fig. 187.



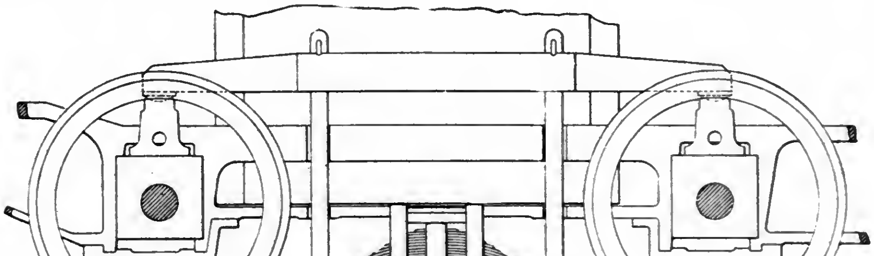


Fig. 188.

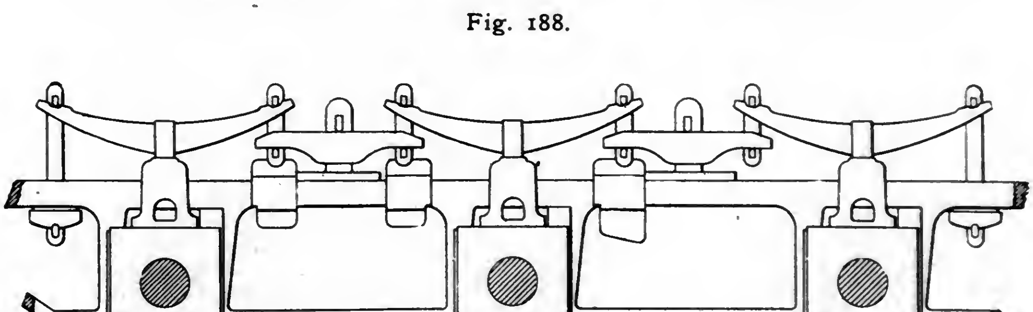


Fig. 189.

condition for the narrow gauge. The first engine with wheels constructed in this way was for the Alabama Great Southern Railroad in 1881. After that all engines built for 5 ft. gauge roads, which it was expected would be changed to the standard gauge, were made in this way.

James Cullen, Master Mechanic of the Nashville, Chattanooga & St. Louis Railroad, to Mr. R. S. Hughes, Secretary and Treasurer of the Rogers Locomotive and Machine Works. The plan was at once adopted for engines for the 5 ft. gauge.

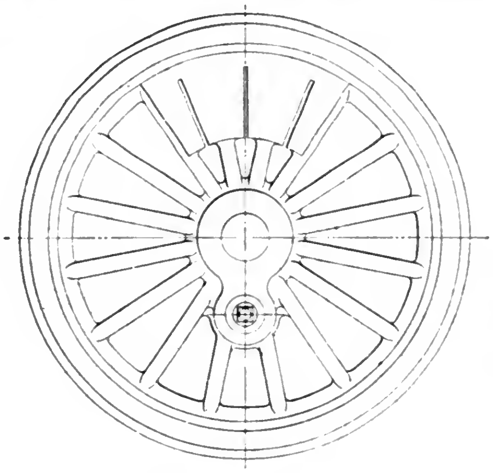


Fig. 190.

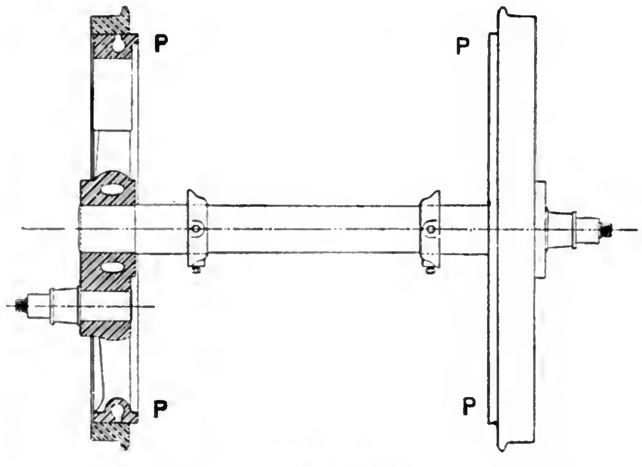


Fig. 191.

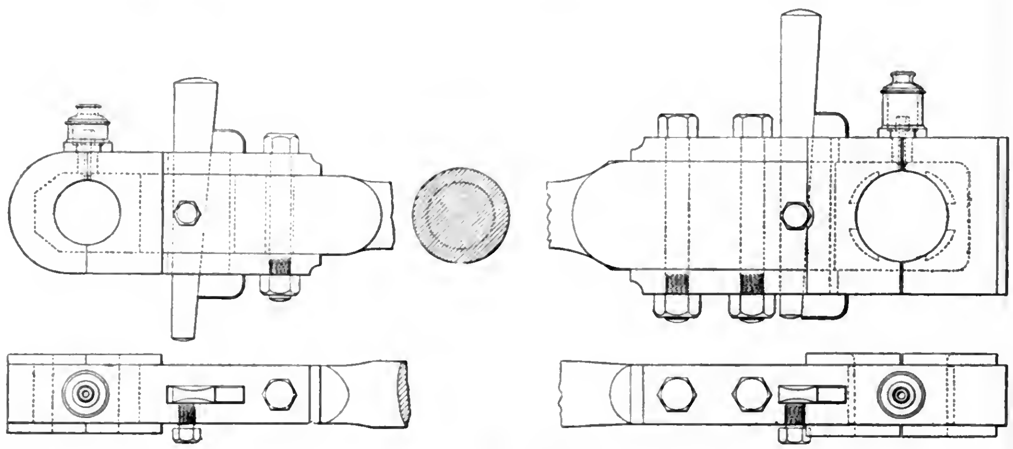


Fig. 192.—1837.

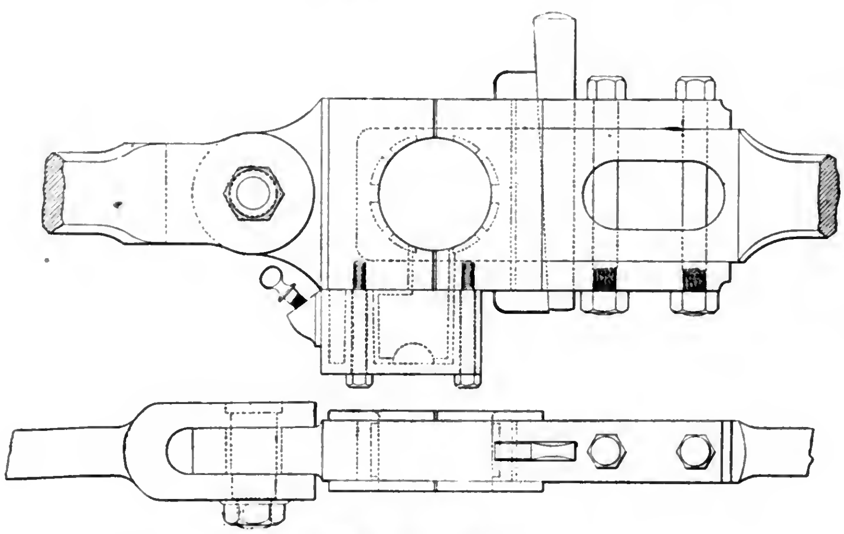


Fig. 193.—1845.

In addition to the extra depth of the rim of the wheel-center the spokes were extended on the outside so as to form a brace or support to the projecting rim. These braces as well as the projection were turned off when the gauge of the wheels was narrowed.

This expedient for changing the gauge was suggested by Mr.

CONNECTING-RODS.

Figs. 192 to 203 represent various forms of connecting-rods which have been made at the Rogers Works at various times. The dates when they were first used are appended to the engravings, which show the construction so clearly that further description is not needed.

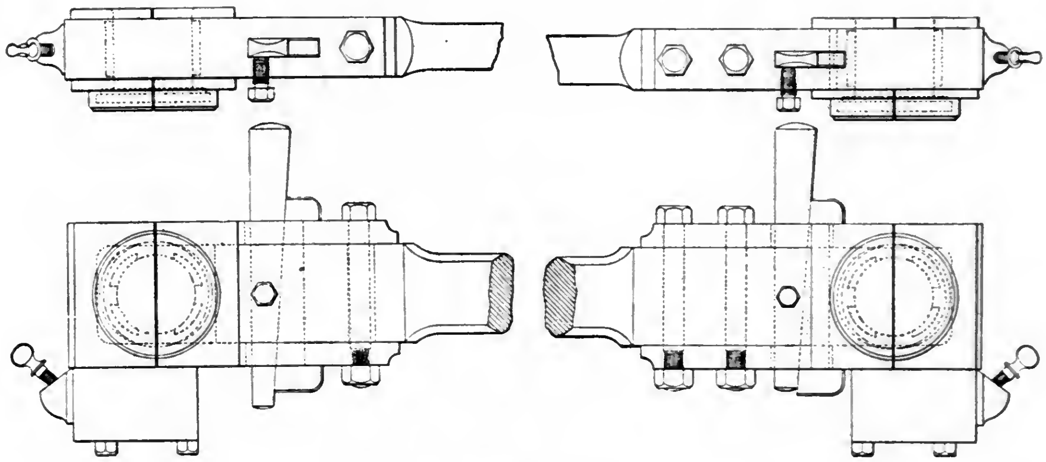


Fig. 194.—1854.

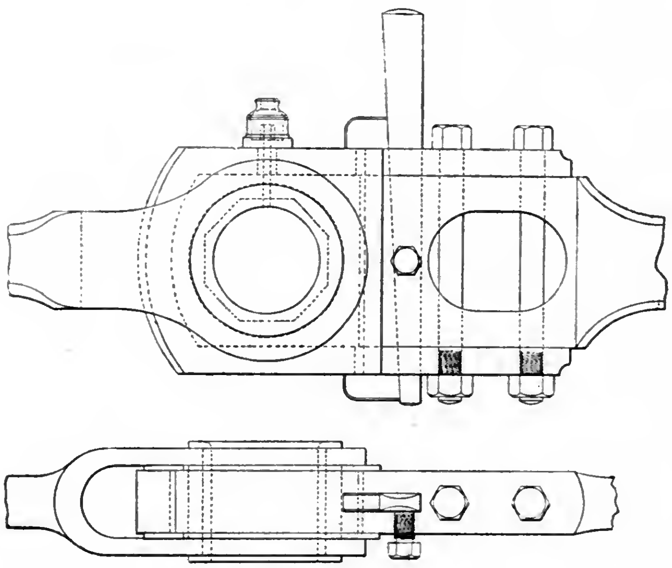


Fig. 195.—1861.

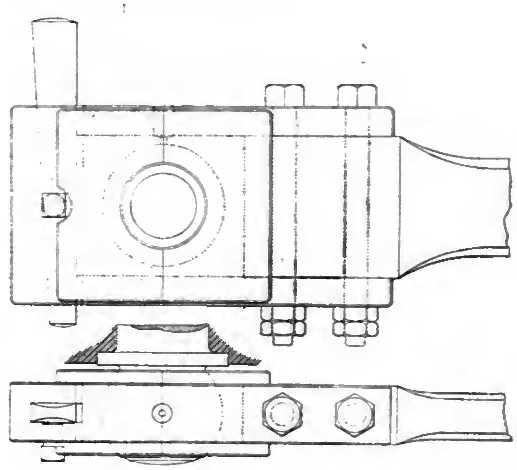


Fig. 196.—1870.

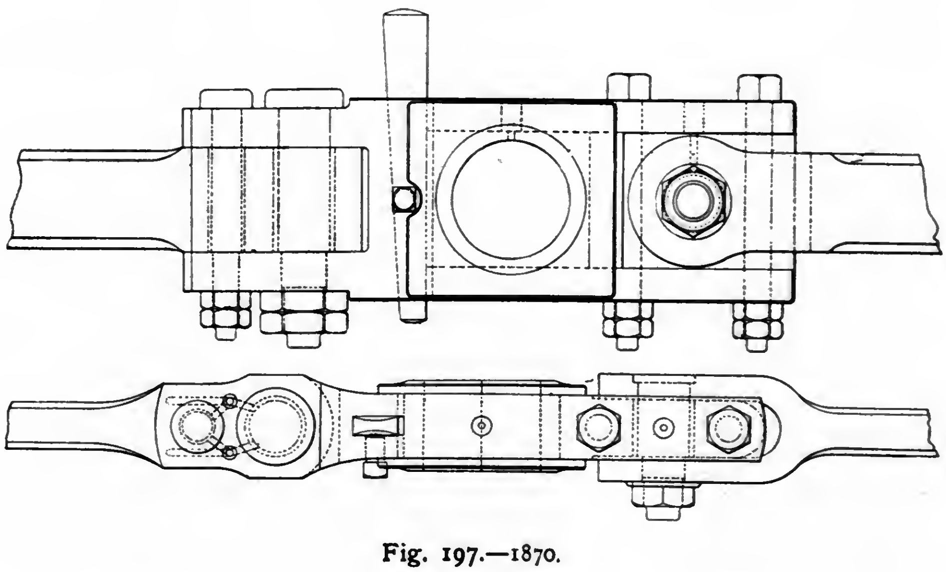


Fig. 197.—1870.

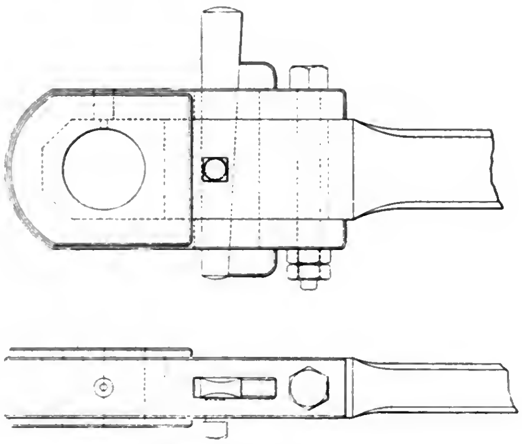


Fig. 198.—1880.

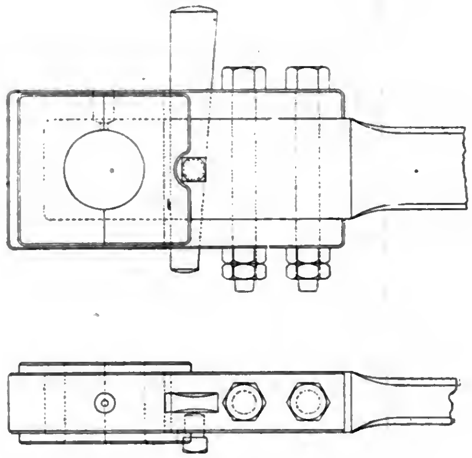


Fig. 199.—1880

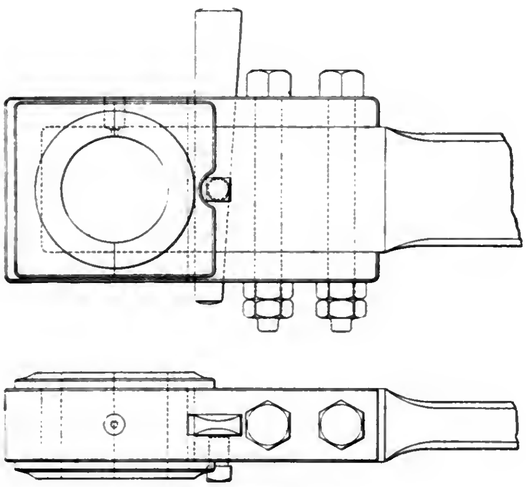


Fig. 200.—1880.

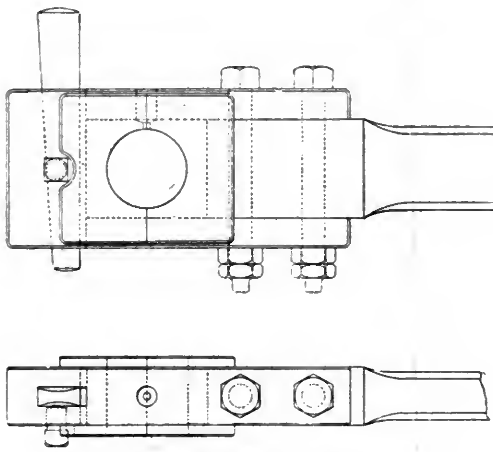


Fig. 201.—1880.

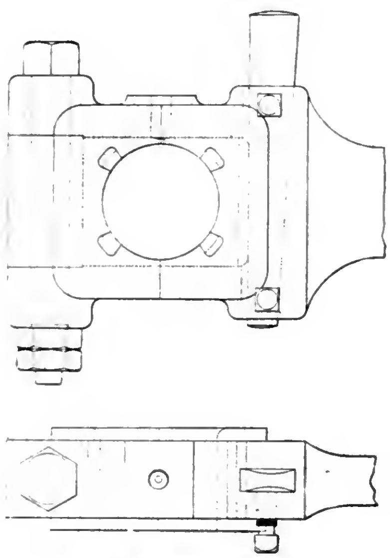


Fig. 202.—1882.

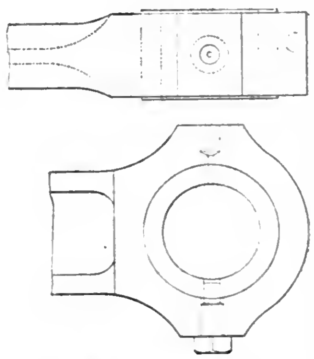


Fig. 203.—1885

(*To be continued.*)

Proceedings of Societies.

American Association of Railroad Chemists.

THIS Association was formed at a meeting held in Chicago in January last. The second meeting was held in Buffalo, N. Y., May 23.

The first day was occupied by a discussion of water for locomotive boilers and the various methods of water analysis, and by a short discussion on disinfectants for railroad use.

On the second day there were discussions on lubricating oils, on the composition of freight-car paint and on illuminating oils.

It was decided to hold the next meeting at Omaha, Neb., September 25.

The officers of the Association are: President, Dr. C. M. Cresson, Baltimore & Ohio; Vice-President, W. L. Brown, Chicago, Burlington & Quincy; Secretary and Treasurer, H. B. Hodges, Union Pacific.

The constitution provides that the sessions of the Association may be private whenever it is considered expedient; that is, whenever papers or discussions may bear upon the quality or composition of products furnished by manufacturers.

Connecticut Civil Engineers & Surveyors' Association.

A REGULAR meeting of this Association was held in Norwich, Conn., June 7. There was a large attendance and a number of new members were admitted.

The members spent a part of the day in visiting the Norwich water-works and several large factories.

In the evening a paper was read by W. H. Burnett, of Norwich, on the Relation of Photography to Engineering, illustrated by views and prints.

Notes giving facts in relation to the various works visited by the party during the day were also read.

Blue prints of Reservoir Dams and Embankments, and Anchor-Ice were distributed by W. H. Richards, of New London, and of a Break in Brick Sewer and a Plan Case by C. E. Chandler.

American Institute of Mining Engineers.

THE 48th meeting of the Institute consists of an excursion leaving Chicago July 1, and taking in Denver, Pueblo, Salt Lake, Butte City (Montana), Helena and the Yellowstone Park. Sessions are to be held at Salt Lake and Butte City, and the members joining in the excursion will reach Duluth on their return on July 24. The total cost of the excursion for each person joining is $260.

The circular from Professor R. W. Raymond, the Secretary, after giving particulars as above, continues:

"The 49th meeting of the Institute will be held at Duluth, Minn., beginning Tuesday evening, July 26. The detailed programme of this meeting will be either communicated in a later circular from this office, or handed to members on their arrival at Duluth. At present it can only be said that there will be—besides the hospitalities and pleasures of Duluth and its harbor—excursions to the Vermilion and Gogebic mines. Letters concerning this meeting may be addressed to Mr. R. S. Munger, Duluth, Minn.

"In view of the result of the above arrangements, in bringing together the two meetings usually separated by several months, there is danger that the number of papers to be included in Vol. XVI of the *Transactions* may fall below the usual average. Members are earnestly requested to prepare papers for one or the other of the meetings announced in this circular. In actual reading of papers preference will be given at each meeting to those which are descriptive of local mines, works or practice; and members residing in or familiar with the mining districts of Utah and Montana, or with the iron ranges of the lake region, are specially urged to prepare such papers. If necessary, time can be allowed after the meeting for perfecting the manuscript for publication. All members intending to have papers presented or read by title at either of the meetings are requested to inform the undersigned at once.

"Vol. XV of the *Transactions* is now nearly complete. If possible, it will be finished before July 1, so as to be distributed in July. Members who have ordered their copies bound will receive them a little later than others. Those who wish their copies bound in half-morocco but have not yet given the order, should do so at once, sending $1 to pay for binding. Volumes once sent in paper covers cannot be subsequently exchanged for bound ones at this price.

"The volume will be sent to such members and associates only as are not in arrears for dues."

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, June 1, President Worthen in the chair. The following elections were announced:

Members: Frank Bruen, New Haven, Conn.; Henry Manson Byllesby, Pittsburgh, Pa.; Samuel Barrett Cushing, Providence, R. I.; Herbert Clark Felton, Camden, N. J.; Silas Bent Russell. St. Louis, Mo.; Robert Somerville, Greenville, Miss.; William Parsons Watson, Helena, Montana.

Juniors: Benjamin Douglas, Detroit, Mich.; Joseph Yendes Wheatley, New York City.

There were on exhibition several models of turrets, gun-carriages, etc., made by the late Captain Eads at the time he was building gunboats for the Mississippi River, and now presented to the Society by his heirs.

Mr. Thompson exhibited a print of the first sleeping-car. This was a lithograph, made in Philadelphia in 1838, of Richard Imlay's "day and night car;" as stated on the print, this car was 50 ft. long, 13 ft. 8 in. high over all, and could carry 150 passengers, having 40 sleeping berths and an apartment for ladies. The car as shown was two stories high, but the interior arrangements were not indicated. One peculiarity seemed to be the attachment of the draft timbers directly to the trucks, without any connection with the body of the car. No one present was able to say whether any car was ever built after Mr. Imlay's plan.

The Secretary read a paper, compiled by himself from the latest authorities, on the German System of Permanent Way with Iron Substructure. It was an account of the German practice in the use of iron ties for railroads. Two interesting facts were stated: First, that the greatest trouble had been caused by splitting or cracking longitudinally, both with cross-ties and longitudinal sleepers; second, that deterioration by corrosion of the metal was greatest under a light traffic.

A brief discussion followed, in which it was stated that no actual experience with paper or glass ties has been recorded.

A REGULAR meeting of this Society was held June 15 at the Society's House in New York.

M. Boulangé, a French engineer, who has been for three years Chief of Section on the Panama Canal, was present and upon invitation addressed the Society, giving some account of the condition of the work upon the canal from his actual experience and observations. He also answered numerous questions which were put to him by members present. He had left his position on the canal on account of a severe attack of Isthmus fever, from which he has just recovered.

The view of the present condition and prospects of the canal given by this gentleman were exceedingly discouraging to those who desire its completion. The total amount of work to be done according to the lowest estimate amounts to 140,000,000 cubic meters of excavation, and of this only 30,000,000 have been done. The canal company has already spent 900,000,000 francs and has at present only money enough on hand to continue the work some 4 or 5 months longer. Not only, said M. Boulangé, has less than one-fourth of the excavation been completed, but two of the most important works in connection with the canal, the damming or diversion of the Chagres River and the improvement of the port of Colon (Aspinwall) have not even been touched.

There has been, apparently, a great lack of system about the work. M. Boulangé said that when he first took charge of his section he asked for a map and profile, but none were furnished him, and he subsequently ascertained that the only map in existence was one made by Lieut. Wyse from his survey, which was not in any sense intended to be a location for a canal, but merely a preliminary reconnoissance. This state of affairs has not been remedied up to the present time, and most of the engineers have been working almost in the dark on their respective sections. In several places excavations have been made of short sections of the canal, while there are intervening sections of which not even a preliminary survey has been made, and no point of junction with the finished work has been indicated.

At the port of Colon there have not even been preliminary

borings, and nothing has been done to ascertain the nature of the bottom or the possibility of improving the channel by dredging. From Colon westward the canal is now open for 16 kilometers, but of this distance the average depth attained is only two meters. Nevertheless, it is expected that there will be an official opening of this short section in the fall, when M. de Lesseps intends to visit the Isthmus. At one point of this section a dredge has been occupied for nearly a year in taking soft clay and mud from the bottom of the canal and dumping it on the bank. The ground, however, is so soft and swampy in its nature that the weight of clay thus dumped raises the bottom of the canal, and the dredge is engaged in apparently an endless tank.

The most difficult work on the canal is at the great cut at Culebra, where there will be a cutting 315 ft. deep and nearly 500 ft. wide at the top. Work has been going on for about a year, and an excavation has been made for a short distance which is now about 38 ft. deep and 70 ft. wide. An unanticipated and very singular difficulty has been encountered here in a movement of the whole mountain, which commenced as soon as work was begun upon the cutting. The cause of this is not known, and the fact has completely puzzled the engineers in charge. It was, however, predicted by the first Chief Engineer that water would be found in this cutting. M. Boulangé believes (and he stated apparently good reasons for his belief) that much of the work already done will have to be abandoned, and it is very likely that a large part of the line of the canal will have to be re-located on lines differing considerably from the Wyse survey.

In answering questions M. Boulangé said that a preliminary study had been made for a canal with locks. Under present conditions no locks could be made and no level established more than 11.8 meters above tidewater to secure a permanent supply of water, but by damming the Chagres and establishing reservoirs this limit might be increased to about 23 meters above tidewater, but the advantage gained in this way would not be very great. In relation to the regulation of the Chagres he considered it a very difficult problem on account of the great volume of water brought down by the river at certain seasons. From his own observation he has known the river to rise 21 ft. in 6 hours. Every Chief Engineer who has been connected with the canal has had a different plan for this work. The first plan proposed required a masonry dam 1,200 ft. long, 210 ft. high and 300 ft. thick at the base. This was abandoned on account of the enormous expense involved and of the uncertainty as to finding proper foundations for such a huge mass of masonry.

At present, a contract for regulating the river has been let to the *Société des Travaux Publiques*, and that society's engineers are now engaged in making surveys and preparing plans. M. Boulangé also stated that a great difficulty in the work had been the scarcity of laborers, owing to the unhealthy nature of the Isthmus. Manual work there is impossible for a white man, and the supply of negroes from the West India Islands had given out, those from Jamaica, Trinidad and the Bahamas declining to go there any more. The average mortality on the canal during one year had been 60 per cent. of all the laborers and 80 per cent. of all the white men. He said that of 72 Frenchmen, assistant engineers, clerks, draftsmen, etc., who went out to Panama a year ago, 45 were dead and only 11 were still at work; 16 of the survivors having been disabled by fever. The men who had stood the work best were negroes who were imported (probably kidnapped) from the East Coast of Africa, but they were not inclined to do much work. The Company had recently resolved to try the experiment of importing Chinamen from Hong Kong and 800 had been brought over, but no more were to be brought until it was ascertained whether these men could stand the climate, as the expense of conveying them to Panama was considerable.

On the Panama end of the canal there is a considerable stretch through low swampy ground where hardly any work has been done, simply for the reason that no man has yet been found who can work there and live.

In answer to questions again, M. Boulangé stated that the current prices paid for excavation under existing contracts were 48 cents per cubic meter for clay; $1.05 for mixed earth and rock; $1.80 for rock from 30 to 100 meters above tidewater; $2.40 for rock from the water level up to 30 meters above. The price paid for rock excavation below water level was kept secret.

A vote of thanks to M. Boulangé for his extremely interesting address was unanimously passed, and the Society then adjourned.

After the Annual Convention in the first week in July no regular meetings will be held until the first Wednesday in September.

Master Mechanics' Association.

THE annual convention began in St. Paul, June 21, First Vice-President Jacob Johann presiding. At the roll-call there were 82 members present.

After the usual addresses of welcome, Mr. Johann delivered his annual address. Some time was then devoted to appropriate memorials of the late President William Woodcock.

There was a short discussion on the use of lump, screened and run-of-mine coal. This was followed by a long and interesting discussion on the use of the straight stack and extension front smoke-box, which occupied the rest of the session.

On the second day Secretary Setchel reported 5 deaths during the year. There are now 251 active, 4 associate and 14 honorary members. Treasurer Richards reported total receipts of $1,935 and a balance of $497 on hand.

An elaborate report was presented by the Committee on Proportions of Locomotive Cylinders, which was discussed. Reports on Traction Increasers, on Piston Rod and Valve Stem Packing and on Cylinder Packing, were presented and discussed. Messrs. Stevens, Lauder and Meehan were appointed to act with the joint committee already appointed by the Master Car-Builders' Association and the Car-Wheel Makers.

On the third day the following reports were presented and briefly discussed. Locomotive Preparation; Coaling-up Locomotives; Standard Form of Tire Section; What Control has the Engineer over the Wear of Driving Wheels.

The majority report of the Committee appointed to prepare a new Constitution and By-Laws was then read, also a minority report recommending a constitution substantially like the present one. The subject, without discussion, was recommitted to the same committee with instructions to give it further consideration and report again next year.

It was resolved to hold the next convention at Alexandria Bay, N. Y., in the Thousand Islands of the St. Lawrence.

The following officers were then elected for the ensuing year, Mr. Jacob Johann having first declined the nomination to the presidency: President, J. H. Setchel; Vice-President, R. H. Briggs; Secretary, Angus Sinclair; Treasurer, George Richards.

After adopting the usual resolutions of thanks the convention adjourned.

After the adjournment the members took an excursion to Red Wing on a train drawn by the Strong locomotive *Duplex*, which was sent to St. Paul for the convention.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the Club's House in Philadelphia, June 4, President T. M. Cleemann in the chair; 18 members and 1 visitor present.

Owing to the unexpected absence of the author, the paper of the evening had to be deferred.

The evening was, however, profitably spent in a general discussion of the proportions and strengths of certain structures which can hardly be calculated with mathematical precision, such as floors built up of separate layers of boards, ribbed and perforated cast-iron chamber and manhole covers, balloon frame buildings, etc. Some interesting illustrations were presented.

A REGULAR meeting was held in Philadelphia, May 21, President T. M. Cleemann in the chair; 33 members and 4 visitors present.

There was some further discussion of the form and arrangement of the proposed U. S. Coast and Geodetic Survey Map of the Delaware and Schuylkill rivers near Philadelphia. The consideration of a resolution expressing the views of the Club was deferred till the next business meeting.

The Secretary presented two communications from Capt. S. C. McCorkle, embodying the following data on the Retardation of the Tide in the Vicinity of Philadelphia, etc.:

"Mr. H. L. Marindin, of the Coast and Geodetic Survey, gives a near *approximation* of the retardation of the tide in the frontage of Philadelphia as about five minutes of time to the mile; *i. e.*, if the time of high water was at a certain time at Fort Mifflin, the time of high water would occur five minutes later for each mile you proceeded up the river.

"Mr. Marindin sends me a little sketch, which I enclose, which shows the time it takes the tidal wave to traverse one nautical mile in the different depths of water. For example, in a bay with 60 ft. of depth of water, it just takes two minutes for the wave to go one mile. Mr. Marindin also says: 'The time of high water and low water at any place can only be determined by a long series of observations, and when the ob-

servations are taken simultaneously they have to be worked up separately, and it is a long job.'

"There has been a long series at Fort Mifflin, and the Engineers of the United States have a long series at Bridesburg, but aside from these two places I do not think there have been observations enough to determine what you want. I deduce, from the observations and conclusions, that, say at Market Street Bridge, Schuylkill, the tide would be 40 minutes later than at Fort Mifflin, and at Bridesburg, on the Delaware, just about one hour later than Fort Mifflin.

"Bench-mark at Gloucester, N. J. (C. S. Report, 1870). 'The bench-mark is the center of a triangle cut in a large block of granite which lies in a granite wall against the river. It is on the river side of the wall, about 50 yards southward from the mark on the northwest corner of the Buena Vista House. It is 7.89 ft. above mean low water, 1.62 ft. above mean high water.

"'The mean level of the Delaware River at Gloucester Ferry, from August 16 to September 8, 1870, was 3.3 ft. higher than the mean level of the sea at Keyport, N. J.' (Office data)."

The Secretary presented, for Mr. W. L. Hoyt, a Multiplication Table, from 1 to 25, for the *Reference Book*.

Mr. John L. Gill, Jr., presented an illustrated discussion as to Whether the Custom of Upsetting the Ends of Bridge Rods Should be Abandoned.

Mr. Arthur Marichal read an illustrated paper on the Construction of Reservoir Walls. After a historic prelude and some remarks about the foundations of such walls, he says:

"What profile should we adopt? This certainly depends upon the forces acting on the wall, viz., its own weight and the water pressure."

Mr. J. E. Codman presented a Diagram for the Regulation of Dimensions, etc., of Cast-iron Flange Pipes, the object being to establish, upon the basis of mathematical proportions, the diameters of flanges and bolt circles, sizes and numbers of bolts and thicknesses of metal, for different diameters of pipes.

Mr. Edward Hurst Brown described a test he had witnessed of Fire-Resisting Paint.

Mr. R. Meade Bache exhibited a Safety Self-Extinguishing Car Stove. The Club then adjourned.

Engineers' Club of Kansas City.

A REGULAR meeting was held in Kansas City, June 18.

A paper was read by Mr. A. J. Mason on Railroad Engineering in Australia.

It was resolved to make the 24-hour system the subject for the next meeting.

Boston Society of Civil Engineers.

A REGULAR meeting was held in Boston, June 15, with 31 members and 3 visitors present. Messrs. George N. Barrus and Nelson Spofford were elected members. The death of George A. Parker, an honorary member, was announced and the usual memorial committee was appointed.

A paper on the Land-slide on the Boston & Maine Railroad at Dover. N. H., in May, 1884, was read by Mr. Edward S. Philbrick.

The Society then adjourned until September.

American Society of Mechanical Engineers.

THE semi-annual meeting of this Society was held at Willard's Hotel, Washington, May 31. President George H. Babcock presided.

At the first day's session Mr. Henry R. Towne read the report of the Committee on Uniform Tests, and Mr. George M. Bond the report of the Committee on Standard Threads for Wrought-Iron Pipe, etc. The Secretary, Mr. F. R. Hutton, presented the report of the Council, which stated that, through Mr. Stephen W. Baldwin, the Society has come into the possession of much of the expert apparatus belonging to the late Mr. John C. Hoadley, of Boston. There has been added to the library the *Transactions* of the Institution of Mechanical Engineering of Great Britain from 1847 to date; also the *Journal* of the Iron & Steel Institute of Great Britain since 1873.

The following papers were presented: Tests of Comparative Value of Different Kinds of Belting, by Samuel Webber; Should a Piston Packing Ring be of the Same Thickness at Every Point, by L. H. Rutherford; Systematic Testing of Turbines in the United States, by R. H. Thurston; Helical Seams in Boiler-Making, by R. H. Thurston. The reading of these papers was followed by discussions. The consideration of various topics of interest to the profession was then begun and occupied the remainder of the morning session.

In the evening the fifth paper, by J. T. Hawkins, on Education of Intuition in Machine-Designing, was discussed by Messrs. Smith, Webber and Denton. The sixth paper, by C. E. Emery, Notes for Discussion on Cylinder Condensation, was discussed by Messrs. Denton, Stirling, Strong and Babcock. The next paper was by the same author on Notes on Limit of Pressure in Marine Engines. The eighth paper, on Comparative Value of Steam and Hot Water for Transmitting Heat and Power, by C. E. Emery, was discussed by Messrs. Porter, Stearns, Wolff and Babcock. The next paper, by Albert Stearns, on Evaporation by Exhaust Steam, was discussed by Messrs. Babcock and Miller.

In the morning of the second day a visit was made to the Bureau of Engraving and Printing, where the different operations of the printing of bank-notes was witnessed; the Smithsonian Institution and the National Museum were also visited.

At 2 P. M. a session was held, when a paper by H. R. Towne, on Methods of Determining Cost and Distribution of Heat and and Power, was presented.

The second paper was by William Kent, A Problem in Profit Sharing, which produced a long discussion on the labor question by Messrs. Hewitt, Hawkins, Towne, Doane, Stirling, Emery, Woolson, Scott, Fowler and Ashworth. The remaining portion of the session was spent in discussing topical questions.

In the evening the members attended a reception given them by Hon. Josiah Dent, on U Street.

In the morning of the third day a trip was made to the home of Washington at Mt. Vernon.

In the evening the fourth session was held. A paper was presented by H. A. Ramsay on What are the Needs of our Navy?

The next paper was by J. Morgan, Jr., on National Defense and its Mechanical Problems. The writer favored building up guns by shrinkage. Discussion followed, by Captain Roger Birney, Lieutenant Wheeler, Messrs. Stirling. Grimshaw and Emery. The session closed after a discussion of topical subjects.

Friday morning was spent in visits to public buildings, and a large number went to Cabin John Bridge, which is said to be the largest stone arch in the world.

The fifth session was in the afternoon. The first paper was by T. S. Crane, on Direct-acting Steam Veneer-Cutters. This paper was illustrated and gave a detailed description of a knife-cutting veneer machine. Discussion followed. Then followed a paper by George H. Babcock, New Method of Making Tubes from Solid Bars, which was discussed by Messrs. Hewitt, Spellman, Kent, Barker, Wilcox and Stirling. The next paper. by James Dredge, was on Gas-Lighting by Incandescence.

After a short discussion on topical subjects the convention adjourned, and most of the members left Washington for home in the evening.

Master Car-Builders' Association.

THE annual Convention of the Master Car-Builders Association opened in Minneapolis, June 14, with about 150 members present. The Convention was opened by a prayer from the Rev. Doctor Tuttle, after which, Mayor Ames of Minneapolis made an address of welcome, to which an appropriate response was made by President Verbryck.

The President then delivered his Annual Address, in which he spoke of the value derived from the conventions and the good results of the experiments which had been made under the auspices of the Association. As an outcome of these experiments there ought to be one automatic car-coupler that could be generally adopted, which would meet with little or no opposition from the various roads and the railroad commissioners.

The report of Secretary M. N. Forney showed that the Association had in 1886, 148 active, 81 representative and 2 associate members, making a total of 231. The membership in 1885 was 223. There were 580,056 cars represented in the Association in 1886, against 486,882 in 1885. The receipts for 1886 were $3,962.16 and the expenditures $3,275.53, leaving a balance of $686.63. The Association owes the Secretary $1,000, however, making a deficit in the treasury.

The usual Committees on Nominations, on Subjects for Investigation, on Correspondence, on Resolutions and on Place for the next Meeting were then appointed.

A resolution was adopted inviting members of the Interstate Commerce Commission and of all State railroad commissions to take part in this and future meetings of the Association.

The Secretary read some correspondence relative to making changes in the Christie brake shoe, which has been adopted by the Association as a standard, but it was decided that it was not advisable to make the changes. The brake shoe is now used by 15 different roads throughout the country.

The Committee on Automatic Brakes reported through Godfrey W. Rhodes, of Aurora, Ill. He referred to the tests which had been made in 1885 and 1886, and the conditions under which the tests were made of the seven or eight of the best devices, including the Carpenter, the Ames and the Card. The report reviewed these tests in detail and pointed out the defects of the various brakes. It is said there was no trouble in securing enough power, but a great deal of difficulty was experienced in securing the quick application of power. This quick application was best secured by the electrical appliances. The principal of using electrical brakes the Committee thinks is the best that has been advanced and they recommend that the Association recognize this fact, but the devices for making use of electricity they consider imperfect. Some extracts from this report will be found on another page.

The Committee on Automatic Couplers for Freight Cars, presented an elaborate and exhaustive report, the conclusions of which will be found on another page. The discussion of this report was postponed until the following day.

After the adjournment, the day was devoted by members to a visit to Fort Snelling and the Falls of Minnehaha, in carriages provided by the Local Committee.

SECOND DAY.

In accordance with the By-Laws of the Association, the morning session was occupied by a consideration of the Rules governing the Condition of and Repairs to Freight-Cars for the Interchange of Traffic. A number of minor points were brought up by members. The rule for the gauge of wheels was changed to read so that cars may be refused if their wheels measure less than 4 ft. 5 in. or more than 4 ft. 5¾ in. between flanges, or less than 5 ft. 4 in. outside treads. Some minor changes of little importance were made. A motion to make a general increase of 10% in prices for cars destroyed, was lost, having received a majority but not a two-thirds vote, and this subject of prices was finally referred to a committee.

The consideration of the Rules of Interchange was taken up again at the afternoon session and occupied a part of the time. The principal subject discussed was again the prices of cars, which were finally fixed at this time. The remainder of the afternoon session was occupied in discussing the report of the Committee on Freight-Car Couplers, which was, as might be expected, very animated. Several amendments offered were voted down, and the report and conclusions of the Committee, as presented, were finally adopted by a majority of the members present and voting. The recommendations of the Committee as to a standard, will, however, under the Rules of the Association, have to be submitted to a letter ballot.

THIRD DAY.

At the third day's session a report from the Committee on Accidents to Trainmen was submitted. This report we print elsewhere.

This report called out a long and animated discussion, the burden of which was that more careful inspection of cars and greater attention to keeping the minor appliances in order were needed. Naturally, a good deal in relation to couplers was said in this discussion, and the general opinion was that the introduction of a diversity of couplers had increased the dangers to trainmen.

The report of the Committee on Standard Draw-gear for Non-automatic Couplers was presented, and after some discussion adopted.

The Committee on Standard Sizes of Lumber for Car Construction presented a report, which was received and the recommendations ordered to be submitted to letter ballot.

The Committee appointed to present a Standard Truck and Axle for cars of 60,000 lbs. Capacity, submitted plans and drawings. This report was likewise received, and the plans ordered to be submitted to a letter ballot.

The Committee on Car Roofs presented a report, which was received and the subject was ordered to be carried over for another year.

The Convention having ordered, in response to a request presented, that a committee be appointed to confer with other committees to be appointed by the car-wheel makers of the country and the Master-Mechanics' Association, in relation to matters pertaining to the construction and use of car-wheels, the President appointed Messrs. J. N. Barr, John Kirby, and George F. Wilson to represent the Master Car-Builders' Association on this Joint Committee.

In view of the limited time remaining, and of the fact that many experiments are at present in progress, the results of which have not been yet determined, the subject of Car-Heating was continued over for a year.

It was voted that the Convention of 1888 be held at Alexandria Bay, N. Y., in the Thousand Islands of the St. Lawrence River.

The business of the Convention was then closed by the adoption of the usual routine resolutions as presented by the committee, and by the election of the following officers.

President—Wm. McWood, Grand Trunk, Montreal, Can.

Vice-Presidents—J. W. Cloud, New York, Lake Erie & Western, Buffalo, N. Y.; E. W. Grieves, Baltimore & Ohio, Baltimore, Md.; John S. Lentz, Pennsylvania & New York, Packerton, Pa.

Treasurer—John Kirby, Lake Shore & Michigan Southern, Cleveland, O.

Executive Committee—Robert C. Blackall, Delaware & Hudson, Albany, N. Y.; R. D. Wade, Richmond & Danville, Richmond, Va.; Joseph Wood, Pennsylvania Company, Fort Wayne, Ind.

After the adjournment of the Convention, the Executive Committee held a meeting and re-elected M. N. Forney Secretary of the Association for the ensuing year.

PERSONALS.

Mr. J. G. Motley has been appointed Chief Engineer of the projected Louisville Southern Railroad.

Mr. J. W. Deen is Engineer in charge of the Aspen Extension of the Denver & Rio Grande Railroad.

W. F. Bradley is now Master Mechanic of the Kanawha & Ohio Railroad. His office is at Charlestown, W. Va.

Mr. J. C. Rhawn is Engineer in charge of construction of the new Clinch Valley line of the Norfolk & Western Railroad.

Mr. T. J. Nicholl has been appointed General Manager of the Natchez, Jackson & Columbus road, with office at Natchez, Miss.

Mr. A. H. Salisbury, late Assistant Engineer, has been appointed Superintendent of Water Works at Lawrence, Mass.

Mr. H. V. Conrad, formerly on the West Shore road, has accepted a position with the Hinkley Locomotive Company in Boston.

Mr. C. M. Cook is appointed Engineer of Maintenance of Way of the Norfolk & Western Railroad, with office at Roanoke, Va.

Mr. J. W. Clarke has been appointed Engineer in charge of road, bridges and buildings of the Gulf, Colorado & Santa Fe road.

Mr. P. H. Peck has been appointed Master Mechanic of the Chicago & Western Indiana Railroad, with office in Chicago.

Mr. F. A. Garvey has resigned his position as Chief Engineer of the Texas & Pacific road, and will engage in business as a contractor.

Colonel James Andrews, of Allegheny, Pa., will it is said, succeed the late Captain Eads as Chief Engineer of the Tehuantepec Ship Railroad.

Mr. C. R. Meeker has been appointed Superintendent of the Oregon Pacific Railroad, with office at Corvallis, Oregon, succeeding F. C. Berell.

Mr. Lewis H. Morse has resigned his position as Superintendent of Bridges and Buildings of the Kansas City, St. Joseph & Council Bluffs road.

Mr. Wm. A. Kellond, Assistant to the General Manager of the Louisville & Nashville road, has resigned that position to go into the iron business in Louisville.

Mr. George L. Chatfield has been appointed Assistant General Master Mechanic of the Chicago, Rock Island & Pacific Railway, with office in Chicago.

Mr. H. G. Holden, late Superintendent of the water-works at Lowell, Mass., is now General Superintendent of the works of Turner, Clark & Rawson, of Boston.

Captain C. B. Percy, late Assistant Engineer of the Mobile & Birmingham Railroad, has resigned that position and is now Assistant Engineer on the Mobile harbor improvements.

Mr. C. W. Lawler has been appointed Superintendent of the Mahanoy Division of the Philadelphia & Reading Railroad. He was recently on the Chicago & Northwestern road.

Mr. Marvin Hughitt, late Vice-President and General Manager of the Chicago & Northwestern Railway Company, has been chosen President in place of Mr. Albert Keep.

Mr. Samuel L. Minot has been appointed Engineer of the Boston & Providence Railroad, and will have charge of track, buildings and bridges. The office is a new one on this road.

Mr C. H. Meade has been appointed Superintendent of the Car Department of the Texas & Pacific Railroad, with office at Marshall, Texas, in place of F. M. Alexander, resigned.

Mr. H. J. Small is appointed Assistant Superintendent of Motive Power of the Philadelphia & Reading road, with office in Reading, Pa. He will have immediate charge of the Reading shops.

Mr. Charles S. Churchill has been appointed Engineer of Maintenance of Way of the Shenandoah Valley Railroad, with office at Milnes, Va. He was recently on the Pennsylvania Railroad.

Mr. Charles H. Morgan, for many years General Superintendent of the Washburn & Moen Manufacturing Company, at Worcester, Mass., has resigned his position that he may obtain much needed rest.

Mr. W. J. Sherman, Assistant Chief Engineer of the Gulf, Colorado & Santa Fe road, is relieved from charge of maintenance of way, and will give his entire time to supervising the building of new road.

Mr. Howard Murphy, Secretary of the Engineers' Club of Philadelphia, and a con-ulting engineer of large practice in Philadelphia, has been appointed a member of the Pennsylvania State Board of Health.

Mr. N. Slingland, Superintendent of Motive Power of the Housatonic Railroad, retired from that position June 20. Mr. Slingland states that he did not resign, but was discharged by the Vice-President, no cause being given.

Professor A. S. Bolles, of Philadelphia, has been appointed Chief of the Bureau of Industrial Statistics of Pennsylvania. He is at present professor in the Wharton School of Finance of the University of Pennsylvania.

Mr. C. W. Bryan, Principal Assistant Engineer of the Edge Moor Iron Company, has resigned that office to accept a position in the bridge department of the Missouri Pacific Railway. His office will be at Washington, Mo.

Mr. A. A. Hobart, formerly Superintendent of the Boston & Lowell and at one time on the Chicago & Northwestern, is reported to be dangerously ill in Boston. He had served also with the Wabash and the Chicago, St. Paul, Minneapolis & Omaha.

Mr. Albert Keep, for many years President of the Chicago & Northwestern Company, has retired from that position, desiring to relinquish the active management of the company on account of increasing age. He has been chosen Chairman of the Board of Directors, a new office.

Brevet Major General John G. Parke, Colonel U. S. Engineers, has been detailed to the command of the Military Academy at West Point, to succeed Brigadier General Merrttt, who is relieved. General Parke has been for a number of years employed on river and harbor improvement work, in which he has had an extended experience.

The Brooks Locomotive Works, at Dunkirk, N. Y., have issued a circular dated June 9, 1887, in which they say: "In officially announcing the death of Mr. H. G. Brooks, the founder of the Brooks Locomotive Works, which occurred on April 20, 1887, we beg to announce the following as the present list of officers: Edward Nichols, President; M. L Hinman, Vice-President and Treasurer; T. M. Hequembourg, Secretary; J. H. Setchel, Superintendent; R. J. Gross, Agent."

NOTES AND NEWS.

Railroads in Sumatra.—The Dutch Government has had surveys made for a railroad in the island of Sumatra, which will be nearly 150 miles long. The chief object is to develop the coal fields on the Umbile River.

Pennsylvania Railroad Relief Department.—The statement of the Relief Department for April shows total payments for the month of $24,543. From February 15 to April 30, the number of death benefits paid was 237; accident benefits, 2,956, sick benefits, 6,537.

Improvements in Puddling.—A new puddling process is on trial in Pittsburgh, by which double the usual amount of metal can be worked at one heat. The use of natural gas makes it possible to produce an even heat over the whole of the large chamber which is substituted for the old furnace.

Electric Motors in Pittsburgh.—Several Pittsburgh gentlemen have organized the Pittsburgh Electrical Motor Company to build and operate motors for passenger railroad lines. The capital stock is $100,000. The following gentlemen are interested in it: Messrs. John E. Ridall, Jas. B. Scott, Oliver Scaife, Geo. L. McFarlane and A. M. Neeper.

Transmitting Power by Water.—The London Hydraulic Power Company's operations now cover a considerable district. There are 20 miles of main pipe laid, in which a pressure of 700 lbs. is constantly maintained. In March last there were 458 machines of different kinds worked by the water-pressure furnished by the Company, an increase of 110 within a year.

A Fast Steamer.—The new steamer *Queen Victoria*, built on the Clyde by the Fairfield Shipbuilding Company, made her first sea trip recently from Greenock to Liverpool. The run was made in 9 hours 23 minutes actual steaming time, or at an average speed of 25.6 miles per hour, in weather not very favorable to speed. The ship is to run between Liverpool and the Isle of Man.

Iron Cars for India.—A correspondent of the London *Engineer* says that the Midland Railway Carriage & Wagon Company has secured an order for 325 wagons for one of the Indian lines. The wagons are made almost wholly of steel and iron, the proportion of wood employed being very trifling. Another company has an order for 300 wagons of a similar character for an Indian road.

Washington Heights Viaduct.—A bridge or viaduct is to be built from the Elevated Railroad station at 155th Street in New York across a strip of low ground to the high ground known as Washington Heights. This viaduct is to be of iron and will be 1,845 ft. long and 50 ft. wide, having a roadway 30 ft. wide and two 10-ft. sidewalks. The viaduct will have a grade of 1 in 20 from the station up.

Heavy Locomotive Mileage.—During the month of May, locomotive No. 317 on the Philadelphia, Wilmington & Baltimore Railroad ran altogether 17,360 miles in passenger service. This is claimed to be the heaviest mileage on record in regular service. The locomotive made two trips each way daily between Philadelphia and Washington, and was run by four different crews, each crew making one trip.

Pressure and Temperature in Artesian Wells.—Heavy machinery is run by artesian-well power in many parts of France, and the experience of the French shows that the deeper the well the greater the pressure and the higher the temperature. At Grenelle, a well sunk to the depth of 1,802 ft., and flowing daily 500,000 gallons, has a pressure of 60 lbs. to the square inch, and the water from this well is so hot that it is used for heating the hospitals in the vicinity.

An Electric Yacht.—At the Royal Albert Docks, London, May 14, the electric yacht *Countess* was launched. The yacht has been built by Lester & Perkins for the Electric Locomotive & Power Company, of London. The boat is 90 ft. long, 11 ft. 6 in. beam and 5 ft. 6 in. deep; she will draw about 3 ft. of water. The motive power will be supplied by Elieson storage cells, and the screw will be driven by an Elieson motor, of the pattern which has already been employed with some success for street car traction.

Russian Oil Pipe Line.—The capacity of the railroad line from Baku to Batoum, Russia, the chief traffic of which is in petroleum, is limited by the very heavy grades at the Suram Pass, where two engines are required to haul a train of 6 tank cars. It is now proposed to put in a pipe line over the pass to help the railroad. Trains from Baku will deliver the oil into tanks at Michaelova, whence it will be pumped to tanks at Kirrilli and thence delivered into tank cars again. The pipe line will be 35 miles long.

Splice-Bars.—Messrs. Morris, Sellers & Co., of the Chicago Splice-Bar Mill, have lately received large orders for the Samson Splice-bar. This joint is used exclusively on the new Minneapolis, Sault Ste. Marie & Atlantic road and its branches. Large orders have also been received from the Kansas City, Memphis & Birmingham and the Atchison, Topeka & Santa Fé; the last-named company has this splice-bar in use on nearly 2 600 miles of track. In all, the Samson joint is now in use on 12,000 miles of track on 170 different roads.

Chicago Water Works.—A plan for the increase of the water supply of Chicago has been prepared by City Engineer J. G. Artingstall. It provides for a tunnel 8 ft. in diameter extending 4 miles out into the lake, and connecting with a

shore tunnel 10 ft. in diameter extending from Grosse Point to the city, a distance of 14 miles. It is thought that the lake tunnel will reach a point where the water is free from sewerage. The capacity of the tunnel will be abont 80,000,000 gallons a day, and the estimated cost is about $4,000,000. It will take some three years to build the tunnels.

Steam Bell-Ringer for Locomotives.—An apparatus for ringing the bell by steam has been placed on several of the passenger engines on the Grand Rapids & Indiana Railroad. It consists of a small steam cylinder placed at one side of the bell-frame and resting on the boiler. The connecting-rod, which connects the piston to a 3-in. crank on the bell, is so constructed that it will vary its length according to the swing of the bell, thus removing the liability of knocking the cylinder head out by the piston coming in contact with it. It is manufactured by Cooke & Strong, of Danville, Illinois.

The Siberian Railroad.—Work on the main line of the Siberian Railroad is advancing rapidly, and the section from Tekaterinberg to Tjumen is nearly completed. In the estimates of the traffic expected for this road are included yearly some 49,000 tons of wheat from Tomsk; 20,000 tons of iron, lead and copper from the mines of the Altai Mountains and Western Siberia. There are also large deposits of coal and salt, not worked at present on account of the lack of transportation, which will be opened when the railroad reaches them. It is also expected that the railroad will develop the overland trade with China and Turkestan.

International Railroad Congress.—The International Congress, which was organized at Brussels in 1885, will hold its second meeting at Milan (Italy), on September 17 next. The object of the Congress is to make and maintain rules for the exchange of business among the railroads of the different European countries. An agreement will be presented for ratification, under which a central office will be established at Berne (Switzerland) for the adjustment of traffic questions, settlement of disputes, claims for loss and damage and similar matters. The want of such an arrangement has long been felt by European railroad officers.

Baltimore & Ohio Employes' Relief Association.—The April sheet of this Association shows payment of benefits to members as follows:

	Number	Amount.
Accidental Deaths	4	$4,000
Accidental Injuries	289	3,769
Natural Deaths	7	4,000
Natural Sickness	495	8,003
Physicians' Bills	157	883
Total	952	$20,655

The payments to members for seven years—May 1, 1880, to April 30, 1887, have amounted to $1,383,983, in all.

Petroleum in Burmah.—Upper Burmah, recently annexed by the English Government, contains petroleum wells which have been worked after a fashion, and from which oil has been obtained in small quantities for a very long time, probably over a thousand years. None of the present wells are over 200 ft. deep, and the oil is raised to the surface by hand. English papers state that analysis has shown that the oil is of good quality, and that arrangements are in progress for developing the wells and testing the productive capacity of the region. The oil field best known is on the Irrawaddy River, only 60 miles from the present terminus of the railroad from Rangoon. It is believed that oil can be found over a large district.

Copper Production of the World.—The production of copper in the world for three years past is estimated as follows, in tons:

	1886.	1885.	1884.
Europe	76,463	76,551	75,410
North America	73,780	77,706	66,750
South America	40,008	44,573	48,269
Africa	6,125	5,700	5,260
Asia	10,000	10,000	10,000
Australia	9,700	11,400	14,100
Total	216,076	225,930	219,789

Of the North American production last year, 69,805 tons are credited to the United States; 3,125 to Canada and Newfoundland and 850 tons to Mexico.

Compound Passenger Locomotive.—A new compound passenger locomotive has been just completed for the North-eastern Railway (England) by Mr. T. W. Worsdell. The engine is inside-connected, the two cylinders being connected to the crank axle in the same way as two ordinary cylinders. There are two pairs of drivers connected, 6 ft. 8¼ in. diameter, and one pair of leading wheels, 4 ft. 7¼ in. diameter. The high-pressure cylinder is 18 in. and the low-pressure cylinder 26 in. diameter; both 24-in. stroke. The valve-motion is on the Joy system. The engine weighs 43¼ tons, the main drivers carrying 18, the trailing-wheels, 12½, and the leading-wheels, 12¾ tons.

A Large Dam.—It is proposed to enlarge the capacity of the water-works supplying San Francisco, and the plan adopted includes the construction of a dam which will be, probably, the largest in the world. This dam will be built across the upper end of the San Mateo Canon, about 4½ miles west of the town of San Mateo, Cal.; it will be 700 ft. long, 170 ft. high, 175 ft. thick at the base, 20 ft. thick at the top.

This dam will make the head of the canon a great storage reservoir, having a capacity of about 32,000,000 gallons. It is claimed that the water collected and stored there will be very pure. The connection between the reservoir and the present water-works will be an expensive work, including a tunnel about 4¾ miles long.

Railroads in Japan.—A German authority gives the condition of railroads in Japan as follows, about the middle of 1886:

	Gov't.	Private.	Total.
In operation	227	120	347
Under construction	68	42	110
Surveyed and located	91	155	246
Projected	100	336	436

Contracts have recently been let in Germany for rails and rolling-stock. A few locomotives have been built in the United States, and there has been some talk recently of further orders coming here, but we have not heard anything definite about the matter.

The Action of Nitrogen on Iron.—Mr. H. N. Warren has subjected specimens of fine merchant iron to the action of nitrogen in ammonia gas while at a bright red heat, and found that on cooling it showed an intense white surface, with increased hardness. Its fracture was crystalline, and resembled that of siliconized steel. It also showed the presence of nitrogen under analysis, through the formation of ammonia. Copper bars also showed similar changes when subjected to nitrogen in the same way. Some of the bars split upon being brought into the atmosphere before they were cold. Mr. Warren thinks this phenomenon due to their absorption of ammonia while heated, and expulsion of it when cooled; an effect similar to the absorption of oxygen by silver.

Brake Patent Suits.—The Westinghouse Air Brake Company and George Westinghouse, Jr., have begun suits against J. F. Carpenter, the inventor of the Carpenter air-brake, for infringement of the Westinghouse patents. The complaint charges that the Carpenter brake, as exhibited at Burlington, is an infringement in several points, the chief ones being the couplings, the brake valve, the train-pipe and the brake cylinder. Mr. Carpenter claims that he has a full defense.

The case will be heard by the United States Circuit Court at Keokuk, Ia., at the July term. Similar suits have been tried in England and Germany, but the Carpenter brake as there used differs considerably from the brake on trial at Burlington, so that the present case is substantially a new one.

A New Coasting Steamer.—The new steamship *Winthrop*, built by the New England Shipbuilding Company to run between New York and Portland, is equipped with boilers and engines from the New England Iron Works, the machinery being designed by the Superintendent of the works. Her engines are triple-expansion, with cylinders 22, 36 and 55 in. in diameter and 36 in. stroke, and intended to run at a speed of 90 revolutions per minute. She has a surface condenser weighing 8 tons. Her propeller is 12 ft. in diameter, and weighs 5,600 lbs. The two boilers are 10 ft. in diameter and 24 ft. long, both of extra quality steel, and calculated to carry a working pressure of 150 lbs. to the square inch. There are three circular furnaces in each boiler. The consumption of coal will be 13 tons in 24 hours.

Kentucky Mineral Deposits.—The report recently issued by the Geological Survey of Kentucky, on the geology of Elliott County, discusses the coal measures of that region, and especially the massive conglomerate, which, along certain uplifts, has been deeply trenched by the streams, the vertical walls of the narrow and exceedingly picturesque gorges ranging from 75 to 175 ft. in height. We also find here full accounts by Messrs. Crandall and Diller of the trap dike of Elliott County, which is noteworthy as being the only mass of eruptive rock yet discovered in Kentucky, and of the interesting possibilities in the way of diamonds suggested by Professor Lewis. But, although this peridotite is similar to that so closely associated with the diamonds in South Africa, Mr. Diller finds no facts which would warrant a persistent search for the gems in Kentucky.—*Science.*

Induction Telegraph For Trains.—The Consolidated Railway Telegraph Company, which now possesses all of the patents covering telegraphing by induction to and from mov-

ing trains, and also contracts with the principal inventors covering future improvements.

Negotiations are pending between the new company and several prominent trunk lines, and it is prepared to open negotiations with railroad companies in the United States and the Canadas for the application of its improved combined system of railway telegraphing upon very favorable terms.

The new "Duplex" feature of the system deserves careful investigation and attention, as by its means one wire may be used for telegraphing simutaneously between stations and between moving trains and stations, thus obviating in many instances the use of any other telegraph line.

An Iron Lighthouse.—The Colwell Iron Works in New York have just completed an iron lighthouse for the Government. It is for Anclote Key, on the west coast of Florida. It is a skeleton lighthouse, 106 ft. high from the base to the top of the lantern chamber. It consists of a hollow central shaft, 6 ft. 6 in. in diameter, secured by heavy posts fastened with radial struts and stiffened by wrought-iron, diagonal tie bolts. When in position it will have a concrete foundation 4 ft. deep and 38 ft. square. The lantern chamber is reached by a spiral iron staircase inside the central shaft. The doorways and windows are solidly storm-proof. Just below the lantern chamber is the watch room, whence the oil is pumped to the lantern. This room is lighted by port-holes in the floor, solidly glazed. The lantern chamber itself is octagonal in shape and about 10 ft. high. The light and the glass sides of the chamber are being made in France. The lighthouse will cost the Government $11,000, and weighs only 75 tons.

The New Cruiser "Atlanta."—The last report of the Naval Advisory Board on the *Atlanta* states that the vessel on her six hours' speed trial developed a collective horse-power only 4.1 per cent. below the requirement of the contract, and that this failure was not due to defective material or workmanship, with the exception of a slight defect in the arrangement for oiling the crank-pins. The Board suggests a few additional changes and improvements, which have been ordered to be carried out by the bureaus.

The entire battery of the ship, including both the 6 and 8-in. guns and their carriages, with steam gear for the latter, are complete. In fact the ordnance officers finished their work on her several weeks ago, and as her ammunition is ready at Ellis Island, no delay in her departure for sea can result on account of her armament. The work recommended by the Advisory Board, including new braces necessary for her boilers, will involve about a month's attention at the New York Navy Yard.—*Army and Navy Register.*

Wood Screws.—Diamond-pointed steel screws are a new article made by the Russell & Erwin Manufacturing Company, of New Britain, Conn., and the following advantages are claimed for them: "They can be driven easily with a hammer their entire length into the most thoroughly seasoned oak, maple, hickory or other hard wood when desired; but in ordinary practice, the best results may be obtained by hammer driving part way, and then turning them in with a screw driver. The characteristic features of these screws are, the *pyramidal point*, the *ratchet thread* and the *convex* or *oval head;* the first two greatly facilitate the penetration of the wood without breaking down its fiber when driven by a hammer, the thread is the best shape to engage with the wood while resisting a pulling strain, and the form of head obviates the liability of its breaking or splitting. In all cases they may be withdrawn with a screw driver, whether they have been hammered or screwed into the wood."

Some personal experience with these screws has proved that they are a valuable addition to the outfit of the wood-worker, and that when once used they will not be discarded.

Safety of Passengers.—Governor Hill, of New York, has approved the bill passed by the last Legislature providing for the safety of railroad passengers in that State. This bill makes it unlawful for any steam railroad after May 1, 1888, "to heat its passenger cars of other than mixed trains by any stove or furnace kept inside the cars or suspended therefrom, except that it may be lawful, in case of accident or other emergency, to temporarily use any such stove or furnace with necessary fuel; provided that, in cars which have been occupied with apparatus to heat by steam, hot-water or hot-air from the locomotive, or from a special car, the present stove may be retained, to be used only when the car is standing still; and provided also, that this act shall not apply to railroads less than 50 miles in length, nor to the use of stoves of a pattern and kind to be approved by the Railroad Commissioners, for cooking purposes, in dining-room cars."

The second section of the law provides that, after November 1, 1887, all railroad bridges shall be provided with floor-systems so constructed as to support a derailed locomotive or car; that is, the floor-systems must be so constructed that, in case of a derailment, the locomotive or car will not break through the floor. All bridges must also, from the same date, be provided with guard-rails and guard-timbers, so arranged as to guide the wheels in case of derailment and to prevent the derailed train or car from running off, or striking the side of the bridge. The guard-rails must also be maintained upon the approaches to all bridges. The penalty for a violation of this section is $1,000 for each offence.

Submarine Torpedo-Boats.—The submarine steam torpedo-vessel *Nordenfelt* has just completed what may be considered a most crucial trial trip as a surface-boat in making the voyage, through at times heavy seas, from Barrow-in-Furness—where she was built—to Southampton, in the neighborhood of which she is shortly to prove her use and enormous offensive capabilities. She was during the voyage tested by her commander in every wind and condition of wave and sea, and by her behavior therein she has shown that she will be capable of being manœuvred in any possible weather, however bad; an advantage possessed by no other torpedo-boat. During the trip no attempt was made to test the speed of the new vessel, only one boiler being used, and that without forced draught. The object aimed at was rather to show how far she could be driven at a fair speed on a small consumption: and on the result, namely, 100 miles on just over 1½ tons of coal, Mr. Nordenfelt is to be congratulated. A higher economy than this will, beyond doubt be obtained with higher pressures than it was convenient to use during this her maiden trip, and when we mention that she is capable of carrying on board upwards of 20 tons of coal, it will be seen how wide her operations may be. The vessel is now in Southampton Docks, having such upper gear as was found necessary for the voyage—such as masts, side-lights, bridge-railings, winches, etc.—taken off her, and is being made to look like what she is, a submarine-boat. She is then to be taken out for speed, progressive, and other trials, the results of which will be given in our columns.—*The Engineer.*

Boiler Explosions in 1886.—The *Locomotive* says: "The total number of explosions, so far as we have been enabled to learn, was 185; in many cases more than one boiler exploded, but it is reported as one explosion.

"The number of persons instantly killed, or so badly injured that they died within a very short time after the accident, was 254; the number injured, many of whom were stated by the report to be fatally injured, was 314, or a grand total of 568 persons killed and badly hurt. This is a showing of which the people of the country at large are not, in all probability, at all proud.

"As has invariably been the case, the greatest number of explosions has been furnished by saw-mill boilers, 24.3 per cent. of the whole number being in this class.

"The next in frequency is the locomotive, 22, or nearly 12 per cent. of the whole being furnished the past year by this class. And yet many writers on the theory of boiler explosions make the assertion, to back up some pet idea, that locomotive boilers rarely explode. Facts do not bear out this assertion. The next largest number occurred among the class of boilers used about mines, collieries, etc., 17 being the total. Some of these explosions were very destructive.

"Distilleries and portable boilers come next with 16 each. Some of the explosions in the latter were especially disastrous their violence would seem to indicate, almost to a certainty strong boilers, plenty of water and very high pressures, probably over-pressure due to neglected safety-valves.

"Rolling-mills and iron works come next with 15 explosions of the usual destructive character common to this class of boilers.

"Steam vessels, which are generally near the head of the list, rank sixth, the total number reported being 14."

Mexican Trade Requirements.—The United States Consul at Guerrero, Mexico, writes: "There is no demand here for machinery of any sort. In agriculture a few small iron plows, it is true, are used, and I believe that they are coming into more general use. The plow used by Mexicans is made out of a crooked fork of a tree, tipped with iron. Their hoes are very wide, heavy, and clumsy. A light hoe would be useless where so many bushes and stumps are left, after their mode of plowing. No mowers, reapers, thrashing machines, or harrows are used or needed, as corn is the only kind of grain cultivated here. Carpenters', blacksmiths' and shoemakers' tools find a ready sale. Washing machines or wash-boards are not used. The washing is done by women, who stand along the banks of the river and scrub the clothes on flat stones, and afterwards hang them out to dry on the bushes. There are no windmills, although they would be particulary useful

for pumping water out of the river for irrigating purposes, as the crops are generally lost because of the drought ; and if artesian wells were sunk they could be used for giving water to stock. In fact, neither agriculture nor stock raising can be profitably carried on here without artesian wells and windmills. A few pumps could be sold here at present, especially pumps for cisterns. It would pay some enterprising person to come to Mexico and put down artesian wells and erect windmills, especially on the plains which extend south of the Sierra Madre. When I speak of machinery I only refer to this consular district ; in the interior of Mexico considerable machinery is being introduced of all kinds. There is no demand in this consular district for mining machinery and implements, as the only mines here are of coal, and they are not worked at present for want of means for transporting the coal. The nearest silver mines are at Cerralvo and Vallecillo, in Nueno Leon, 90 miles distant. No electric machiney would sell here at present."

A New Valve-Gear.—In a paper on New Constructions of High-speed Engines, presented to the *Verein zur Beförderung des Gewerbfleisses* (Germany), a short time ago, Dr. Proell, among other things, described his system of valve-gearing, which has found much favor with German engine builders. His remarks are therefore not without interest:

In place of four flat-balanced slide-valves, as used in the Porter-Allen engine, a cylindrical oscillating valve is employed, placed below the cylinder. The axis of the valve is at right angles with that of the cylinder. The steam passes through the inside of the valve ; the ports are in that part of the surface furthest from the cylinder. The weight of the valve rests on the wearing surface, and all the lubricant from the cylinder flows to it down the steam passages. In consequence of the low position of the valve the condensed water runs off from the cylinder of itself. To insure sufficient admission area with an early cut-off there are two passages in the valve by which the steam can enter. Motion is given through a crank attached to the valve spindle by an eccentric-rod. Instead of the curved link of the Porter-Allen engine a straight bolt is used on which the block connected with the eccentric-rod slides. In order to obtain a constant lead for various degrees of expansion a double motion is employed, both the rod and the eccentric strap being adjusted by the governor. A special construction of governor of Dr. Proell's design is also used ; it is of the inverted type, a spring taking the place of the counterweight in ordinary governors. The distinctive feature consists in the fact of the proportions being so arranged that the balls always move approximately in a plane at right angles to the governor-spindle, so that when the latter is vertical no work is performed by the weight of the balls. The action is approximately astatic. In the larger machines of this type a longitudinal reciprocating motion is imparted to the valve, not synchronous with the oscillations of the latter. This, it is claimed, makes the wear very uniform, prevents grooving, and reduces the friction, thus rendering easier the work of the governor.

Cornell University.—Professor R. H. Thurston, Director of the Sibley College (the department of mechanical engineering) of Cornell University, has issued the following circular:

"An unexpectedly rapid growth in the numbers of students registering in the Cornell University for the Sibley College courses, in the past two years, and since their establishment on their present basis, has already crowded that institution to its utmost capacity in many directions, the number in the college having already approached, within 25, that considered the maximum which can be accommodated in the existing buildings. A new building now in progress—under contracts made by the Hon. Hiram Sibley and which will be presented to the University—will, however, increase the total space available next year by 50 per cent., and will bring the total number, as a maximum, when all classes are filled on the new basis, up to 300.

"This enlargement of the Sibley College will make it possible, under the conditions stated in the *Register* of the University, to increase the number admitted into the Freshman Class to 100; while 25 or more may be admitted into the upper classes and the advanced courses of post-graduate instruction. Should more apply than the number just specified, preference will be given to those shown by the results of the examinations for admission to be best prepared. Students unable to register in the Sibley College courses leading to a degree may, if they choose, enter any other courses for which they may have sufficient preparation.

"It is hoped that, at a later time, when further extensions of the buildings, additions of proportional extent to the equipment, and the growth of the income of the University and of the assured income of the college shall have permitted still further development of the Sibley College system of schools and of related departments of the University, the limit, as to numbers, may be again extended so as to permit the admission of all applicants well fitted to profit by such instruction as is here offered. At present, only those who are well prepared can be certain of admission to the courses leading to a degree."

Blast Furnaces of the Uuited States. — The *American Manufacturer*, after giving its usual monthly tables, says: "In a condensed form, the statistics of the furnaces for June 1, is as follows :

Fuel.	In blast. No.	In blast. Weekly capacity.	Out of blast. No.	Out of blast. Weekly capacity.
Charcoal	62	11,809	116	12,738
Anthracite	145	41,288	60	15,503
Bituminous	104	54,767	105	57,348
Total	311	107,964	281	85,589

The most noticeable change in this report, as compared not only with that of last month but with that for many previous months, is the falling off in the number of bituminous furnaces in blast. Since March 1, 1886, there have not been so few furnaces in blast. At that time the small number, 105 just, was owing to a coke strike, the same cause that has reduced the number of furnaces in blast at the present time. It is probable that if all the furnaces that were banked June 1, had been reported as banked and included in the table as out of blast, the number would have been reduced below 100, a smaller number than has been in blast at any time since November 1, 1885.

"The chief changes have been in the Pittsburgh and Shenango Valley districts in Pennsylvania, the Mahoning Valley and Eastern Central and Northern districts in Ohio and in Illinois, 32 of the 45 furnaces less in blast being reported in these districts. In the South, with the exception of Virginia, there has been an increase in furnaces blowing. Some of the Virginia furnaces use a portion of Connellsville coke and are out of blast or banked.

"Furnaces using other fuel than coke show but little change, though anthracite furnaces, which use considerable coke, would show a considerable falling off in the actual make."

A year ago, on June 1, 1886, there were in blast 308 furnaces (54 charcoal, 123 anthracite and 131 bituminous), having a total weekly capacity of 118,770 tons.

Promotion of Locomotive Engineers.—Mr. G.W. Cushing, Superintendent of Motive Power and Rolling Equipment of the Philadelphia & Reading Railroad, has issued the following circular in relation to promotions :

"Cases having recently come to notice indicating the necessity for a settled, understood system in the matter of promotions of men, this circular is therefore issued for information of employés interested.

"Promotion to road-engineer necessitates regular service as fireman on the P. & R. R. R., and it may become expedient to choose from the ranks of firemen men for switch-engines and work-trains. Where the circumstances are favorable, firemen may first be used as hostlers, until thoroughly familiar with that important line of duty, and advance through the grade of shifting and pusher engineers, to regular road service, if found in all respects capable and worthy. Those firemen will be selected who possess a good record for regular habits, who stand well as men, and who are sufficiently educated in their duty to become creditable to the service. None who are known to use liquors in any quantity as a beverage will be selected ; with this in view it will be well for the firemen to seek information relative to their duty, and to fit themselves for advancement ; to those who are so disposed, the officials of the railroad connected with the machinery department will cheerfully give such information as time and circumstances will permit. The road foreman will instruct engineers and firemen in all matters they desire to know.

"Those who are advanced to the grade of road engineer will retain that rank. In case at any time it becomes necessary to decrease the number of road engineers, those who are dispensed with will be offered temporary places in a lower grade, the youngest to switch engineers and firemen, but their places in proper rank will be held open for them.

"Selections for passenger-train engineers will hereafter be made from the ranks of freight engineers ; the oldest in service, if worthy and capable in all respects, will have the preference. Men who are offered passenger-runs and decline to accept them, will thereby waive their right to the run offered, and it will remain discretional thereafter if they shall again be offered the passenger-run.

"All men employed as road engineers shall be required to

pass examination before the Division Superintendents or their representatives, relative to their understanding of the transportation time-tables, or book of rules, and the interpretation given by the Superintendent must be accepted and acted upon by the engineer. In cases of dullness in comprehending rules, the Superintendent will decline to certify to the fitness of the applicant, in which case he will not be employed as locomotive engineer."

The Vogelsang Propeller.—The Vogelsang propeller is now attracting the attention of Navy men by reason of the remarkable accounts received here of its performances in Europe. It is stated that when applied to a German torpedo-boat, without any increase of power, the speed of the boat was increased from 21 knots to over 26 knots. There is trustworthy evidence that it has increased the speed of a number of launches and other small craft as much as 33⅓ per cent. This invention is about to be tried on one of the North German Lloyd steamers between Bremerhaven and London. It was developed by the inventor at the Washington Navy Yard, an it seems strange that it was never officially reported upon here. Mr. Vogelsang's patent covers the following claims:

"1. A propeller consisting of a hub provided with two or more blades or wings grouped upon but one side and unequally distributed about said hub, but in which the distance between the blades is not uniform, and in which no two blades are diametrically opposite, substantially as and for the purpose specified.

"2. A propeller having its blades grouped upon one side of the hub or shaft only and in which no two blades are diametrically opposite, and in which the distance between the blades is not uniform, and a non-propulsive counterbalance arranged upon the side of the hub or shaft opposite to that on which the blades are located, substantially as and for the purpose specified.

"3. A propeller consisting of a boss or hub provided with two or more blades grouped upon one side only of the said hub, and in which no two blades of the group are arranged diametrically opposite, and a single blade arranged opposite to the group of blades, but in which the distance between the blades is not uniform, substantially as and for the purpose specified."

The inventor says of what he has been able to accomplish: "With propellers in which there are a large number of equally distributed blades, the water is so greatly churned that it is difficult for the blades to obtain a solid hold in the fluid, and consequently the loss by slippage is very great. By arranging the blades as herein described and shown, forming a more open space between them, they are enabled to take a firm hold upon the water, and the slip is much reduced, and this reduction is shown in an increase of speed with a given number of revolutions. It is also evident that as the blades are located to one side, one side of the shaft will take the wear and will run upon the bearing-box, the pressure traveling around the box instead of around the shaft, as heretofore. This change of pressure is very advantageous, as the box may be made with a replaceable bearing, and the life of the propeller-shaft would be greatly lengthened."—*Army and Navy Register.*

The Use of Wolfram or Tungsten.—For the last 30 years the beneficial effects of an addition of wolfram or tungsten to steel have been fully recognized, but the error has so often been made to employ as an addition an impure tungsten that results have varied considerably and have depreciated to some extent the value of the steel. Going on the idea that the cause of this variation in the results is the use of impure tungsten carrying either sulphur or phosphorus, or both, Mr. Theodore Kniesche, of Rosswein, Saxony, started on the plan of producing first a pure tungsten which would secure uniformity of results. Steel alloyed with pure tungsten is remarkable for its hardness and toughness, the cost being only slightly greater as compared to the improvement in quality. It is stated also that tungsten steel is very suitable for the manufacture of steel magnets, since it retains its magnetism longer than ordinary steel. Mr. Kniesche has made tungsten up to 98 per cent. fine a specialty, and has introduced it at Krupp's and a number of Sheffield and French steel manufacturers. Dr. Heppe, of Lindenau, Leipzig, has written a number of articles in German technical publications on the subject. The following instructions are given concerning the use of tungsten: In order to produce cast-iron possessing great hardness an addition of ½ to 1½ per cent. of tungsten is all that is needed. For bar-iron it must be carried up to 1 to 2 per cent., but should not exceed 2½ per cent. For puddled steel the range is larger, but an addition beyond 3½ per cent. only increases the hardness so that it is brought up to 1½ per cent. only for special tools, coinage dies, drills, etc. For tires, 2½ to 5 per cent. have proved best, and for axles, ½ to 1½ per cent. Cast-steel to which tungsten has been added needs a higher temperature for tempering than ordinary steel, and should be hardened only between yellow, red and white. Chisels made of tungsten steel should be drawn between cherry-red and blue, and stand well on iron and steel. Tempering is best done in a mixture of 5 parts of yellow rosin, 3 parts of tar and 2 parts of of tallow, and then the article is once more heated and then as ordinarily tempered in water of about 15° Centigrade.

It has been repeatedly shown that good tungsten steel can also be produced in a Bessemer converter, but the drawback is that part of the tungsten is burned, and its consumption, therefore, is greater than in the case of crucible steel, but it has been successfully tried to carry all of the tungsten added to pig-iron in a cupola. Pure tungsten is a powder, and, therefore, a greater part of it would be blown out of a cupola if it were put in any other form; therefore, the metal is mixed with one part of slack lime perfectly dry and enough hot tar to make small bricquettes. A layer of coke is put on the bottom of the cupola, followed by a layer of these bricquettes, covered with some coke, and then a charge of pig-iron with lime as a flux; following them in regular order charges of coke, bricquettes, pig-iron, etc., until the furnace is full. After the iron is melted it must be well stirred and kept hot for half an hour. Alloys of tungsten with bronze have been found very suitable. A tungsten bronze containing 1½ per cent. of tungsten, 95 per cent. of copper and 3½ per cent. of tin is very tough and rolls well.

The North Sea Canal.—Work was formally begun June 2, on the North Sea Ship-Canal, which is to extend from the Bay of Kiel on the Baltic Sea to the River Elbe near its mouth. This canal will enable vessels to pass from the Baltic to the North Sea, avoiding the long and dangerous passage around Denmark. It will be the realization of a very old project, a canal having been first proposed 500 years ago.

The canal itself, which will be a clear cut from sea to sea, will have locks at both ends, with tide-gates to insure communication at any hour and under any condition of tides or temporary currents. Leaving the Elbe in a northeasterly direction it will be cut through sandy soil to the Lake of Kuden (8 kilometers), where considerable engineering difficulties will have to be overcome on account of the marshy character of the ground. After crossing the Lake of Kuden the canal follows for awhile the valley of the little River Burgeran to the village of Burg, 15 km. from the starting point.

At a point 5 km. further it strikes the river Koltenau, which is crossed and recrossed, and a tributary of which is followed through rising ground to Klein and Gross-Bornholt (27 km.) and Groendal, the highest point of the route. Here excavations to the depth of 30 meters will be made through sandy loam. At Wennbuettel (32 km.) the valley of the Giesel River will be reached. Here the canal turns a northeasterly direction to the East, following the Giesel River for about 10 km. to a place called Oldenbuettel, where a cut of about 4 km. across the land will connect it with the lower Eider at Wittenbargen. This River Eider, and particularly the upper Eider, with the lakes formed by it, and the surface of which is considerably higher than the mean level of the sea, will play an important part in the projected Nord-Ostsee-Kanal. It will be followed from Wittembargen to Bendsburg, a distance of 20 km.; thence the lakes formed by the upper Eider (10 km,) will be used to Steinrade, whence a cut of 7 km. will be made to Koenigsfoerde, and thence to the lake of Flemhude, which will be crossed near it northern end (86 km. from the starting point). The remainder of the Nord-Ostsee-Kanal will be an enlargement of the present small Eider-Kanal with short cuts near the town of Knoop (95 km.).

Near Holtenau, at the terminus of the present Eider-Kanal (built by King Christian VII of Denmark in 1785), the port of Kiel on the East or Baltic Sea will be reached.

The total length of the canal from Kiel to the Elbe will be 99 km. (61.5 miles). It is to have a uniform width of 60 meters (196.9 ft.) on top and 26 meters (85.3 ft.) at the bottom, and the depth of water will be 8.5 meters (27.9 ft.). The German Government is building it, largely for strategical reasons.

Compressed Air Power.—Satisfactory progress is being made with the construction of the central station of the Birmingham Compressed Air Power Company, and in the course of the next two or three months operations will have been so far advanced that consumers will be supplied with the new motive-power to the extent of 6,000 I. H. P. Already applications for 3,500 I. H. P. have been received. As the area for supplying compressed air is limited under Act of Parliament to about 1½ square miles, the operations of the company will at first be confined, but, on their enterprise being attended with success, steps will doubtless be taken to acquire powers or extending the area.

At the central station the air will be compressed to a pressure of four atmospheres by large air-compressing engines, and will be conveyed in mains through the principal streets of the locality, and from these mains service pipes are to be taken to the premises of the company's customers. The works will have a railway siding from the Midland line, from which coal will be tipped direct on the charging platforms of 31 of Wilson's 8-cwts. patent gas producers. Underground flues will carry the gas from the producers to the furnaces of the boilers. The steam injection to the gas-producers will be taken from a separate boiler, and will be goverened by air pressure, so that when the air pressure rises the steam injection will be reduced and the fires under the boilers lowered throughout the whole range, and *vice versa*.

When the station is completed there will be 15 engine-houses, built in rows, of strong concrete walls, in the spaces between which will be placed 45 Lane's patent water-tube boilers. Each engine-house will be constructed to receive one triple-expansion beam air-compressing engine of 1,000 I. H. P., driving six single-acting air-compressing cylinders, coupled to opposite ends of the beams, and capable in the aggregate of delivering 2,000 cubic feet of air per minute at 45 lbs. per square inch above atmospheric pressure. The free air will be drawn into the compressors from the top of each engine-house through casings, in which will be inserted filtering screens to clear the air of solid impurities. When the full 15,000 indicated horse-power is at work, 6,000,000 gallons of water will be used daily for the feed, for condensing, and for cooling the air-cylinders. The mains will vary in diameter from 7 in. to 24 in., and will extend about 18 miles. They will be placed in concrete troughs, supplied with removable covers, as near as possible to the surface of the road; and means will be adopted by which, in the event of the bursting of a pipe, the general supply shall not be interrupted. Service pipes will be connected in the usual manner, and Forster's patent joints will be used, so as to allow for expansion, contraction, and for any subsidence or other disturbance. Consumers will have the air supplied through meters of the character of Beale's gas-exhauster, corrected in the readings according to the varying pressure.—*Correspondence of the Engineer.*

A New Telephone.—I was invited to be present to-day at some telephone experiments between Paris and Brussels with a new apparatus known as the "micro-telephone push-button." These experiments, which were made on behalf of the two telegraphic administrative departments of France and Belgium, produced a very lively impression on those present, and I believe the new apparatus to be the most perfect yet produced.

As its name indicates, it has the form of an ordinary electric push-button. When the button has been pushed in, and has made a sound at the other extremity, it is taken out, and is found to be attached to a long electric wire There is thus exposed the telephonic plate, which is extremely sensitive, so that where it is necessary to speak at short distances it is not necessary to come close to the instrument. For communications in the same street, or the same house, the operator places the upper part near himself, and without changing his position he can speak with the correspondent at the opposite extremity. He is not obliged to put his ear to the part which contains the button and brings back the reply. Thus, for short distances, those who make use of this apparatus speak in their ordinary tone, without changing their customary attitudes. They may sit or walk about, and speak just as if those they were addressing were present. When great distances intervene, as in the experiments performed to-day, in which the speakers and hearers were separated by 200 miles, it is necessary to come nearer to the apparatus, but without being obliged to speak quite close to it.

But what makes this apparatus the most successful of telephonic instruments is, that it can be made for 60 cents, that is to say, for not more than the price of the ordinary push-button. Now, as it can be fitted to the electric wire of the ordinary ringing apparatus, it follows that it introduces a complete change in our ordinary modes of intercourse. At front doors, in the interior rooms of houses, everywhere in short, where the ordinary electric buttons are used, the telephonic buttons may be introduced. It will by this means be possible to give or receive instructions, to know who is knocking at the door, to communieate in short, by speaking as well as by ringing. On the advantage of this in every-day life it is unnecessary to dwell. The railway companies are making experiments with this apparatus as a means of communication between compartments of carriages. It is being fitted up on trial in hotels. I have seen it at work at the door of a private house, where I was replied to by those within without their having stirred from their places, and without the door being opened. Between Paris and Brussels this instrument, costing 60 cents, worked with admirable precision, and it was not altogether without an eerie feeling that I listened to a voice with a slight Belgian accent coming to me from a distance of more than 200 miles.

The inventor is Dr. Cornelius Herz, one day nominated Grand Officer of the Legion of Honor, next day described as an emissary of Germany, and lastly as the friend, adviser and confidant of Gen. Boulanger. He is in reality an electrician whose inventive talent has been stimulated by his residence in America, where there is a boundless demand for improvements in electrical apparatus and in all mechanical contrivances. The French Minister of Posts and Telegraphs, under whose auspices the experiments were carried out to-day, has approved the report made to him, and proposes to give orders for the introduction of the new apparatus into all the public administrative departments as soon as it comes into use, for as yet it has only been an experiment.—*London Times, Paris Correspondence.*

Chicago, Burlington & Quincy Master Mechanics' Association.—The division master mechanics of the Chicago, Burlington & Quincy and its controlled lines, have an association which holds periodical meetings for the discussions of questions of interest to them either generally or in their special relations to the road. As a specimen of their work, we give the following, which were among the questions submitted at the sixth meeting:

602. Should we use check-chains on tank trucks and passenger cars?

603. Is there uniformity of standards in tools, oil cans, etc., furnished engines; and if not now practiced, should not the number of engine and initial of road be branded on tools as far as practicable?

604. Is it desirable that the recess now cast in rocker boxes be left out, giving the rocker-arm the benefit of the full bearing? The rocker box is 12 in. long over all, with a recess in the center. It is claimed that it would cost no more to bore it out with this recess left out, and would wear without lost motion much longer.

605. It is recommended that coach draft timbers be made out of lumber 7½ × 4 in. and 16 ft. long, instead of 13½ × 4 in. and 16 ft. long, and to put the upper 6-in. piece on with bolts and cast-iron keys. The argument is that it would be equally as strong and cost much less money.

606. What is the best arrangement for fastening front doors in extension-front engines?

607. What is the difference in cost of maintenance of balanced as compared with plain D valves?

608. It is recommended that the brake bracket and casting for flat and coal cars be secured to the end-sill by a different fastening. They are now held by one end of the truss-rod of the car, and, it is claimed, the strain of the load on the rod has a tendency to pull the brake staff out of plumb, hence the bracket should be secured independent of the truss-rod.

609. It is recommended that a change should be made in the brake shoe on the M. C. B. trucks where the brake is hung to the truck on the inside, so the car repairers can get the split key in more readily. It is claimed that with the present construction about half of these keys are put in from the bottom, and a poor job is the result.

610. The use of studs is recommended in place of T-bolts in fastening steam pipes to the saddle on class A engines. It is said that T-bolts, when in use 1 or 2 years, rust in and are liable to break the casting getting them out.

611. It is recommended that the stuffing-box and stem be left off boiler checks and a plain cover made. It is said to work better and is cheaper to make.

612. Would it not be better to make the link-block separate from the side-plate instead of solid? It is considered cheaper to make and could be readily closed when worn, while the solid block has to be thrown away.

613. Would it not be better in painting freight cars to use mineral for all work including iron work? It is thought a large saving would be effected and the iron be as well protected.

614. Would it not be better in building and rebuilding stock cars to put the end sills on like they are on flat and coal cars? This would do away with corner irons which it is thought is a detriment to end sills, causing them to rot where covered with iron, and effect economy both in repairs and new work.

616. It is recommended that the location of class A engine water-gauge glasses be raised 1⅜ in., which, when the water can barely be seen in the glass, will leave 3 in. of water on the crown-sheet, water in the lowest gauge-cock indicating 4 in.; while, it is said, our present location of gauge glass allows but 1⅝ in. of water on crown-sheet when water can barely be seen in glass and it is considered unsafe.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART, ... Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery Avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, AUGUST, 1887.

So much has been written about the use of torpedoes as weapons both of attack and defense in naval warfare, and so much reliance is placed on them for coast defense, that very few people realize the fact that experience with them in actual service has been very small. Since the torpedo has been fully developed there has been no great naval war, and in the very few cases where they have apparently been of service, it has been the fear of torpedoes, rather than the torpedoes themselves, which have been effectual.

For this reason a great deal of interest has attached to the remarkable series of experiments which the English Navy has been making with torpedoes in attacking an iron-clad vessel. In this case the assailants were really given every possible advantage; they were working against an old ship, not under steam, not manned while the attack lasted, and placed there simply for the purpose of being destroyed. And yet, with all these advantages, they failed to make any impression; and finally only destroyed the vessel by carefully and deliberately fastening a torpedo under the bottom of the ship and then exploding it—a proceeding which would, of course, be impossible in warfare.

The indication of these experiments is that something more effective than has yet been devised will be needed to attack a war-vessel provided with the proper means of defense; and those means are neither very elaborate nor very hard to handle.

AN article which will be read with interest, on another page gives an account of English experience with underground telegraph wires, written by an engineer who has had an extended experience in that direction. His testimony is, that the simplest means used there have been found the best in almost every respect, and the problem of burying the wires, which has been made to appear so difficult in New York, is really a comparatively easy one. In London, nearly all the over-head wires of the telegraph have been dispensed with as a matter of convenience, and new subways are put down with very little more labor than is required to lay an ordinary drain or small sewer. And in London the conditions are quite as unfavorable for such work as in New York.

The statistics of track-laying collected by the Chicago *Railway Age* show that in the first half of 1887 there were 3,754 miles of new road added to the railroad system of the United States. By far the greater part of this new mileage is in the far West and the Southwest, Kansas, Texas, Nebraska, Dakota, California and the Indian Territory leading in the list. The Eastern States show only a very small mileage.

Much of the new Western mileage is to develop and serve new country, but a large part of it is in the nature of parallel road, intended to divide business and add to the territory of rival systems. The increasing tendency to this sort of work is to be regretted.

The *Age* estimates that the total track-laying for the year will not be less than 10,000 miles. Considering the number of long lines in progress, and the fact that work began late, this seems to be a very conservative estimate.

AT the closing exercises of the Baltimore & Ohio Railroad Technological School, Professor Johnson said:

> Theory is simply law deduced from a number of practical experiments applied to a new case. In illustration, the best form for side-rods of locomotives might be determined practically or theoretically. By the first means one form of rod would be used, when it broke another form would be tried, and so on until after perhaps many costly accidents the proper form might be found, which on the other hand might have been previously calculated.

There are probably a number of locomotive superintendents who would be very much obliged to Professor Johnson if he would explain how, by calculation, they can know whether their coupling rods are strong enough.

THE old idea of utilizing the great water-power of the Niagara River is revived in a new form at Buffalo, where it is proposed to raise by subscription $100,000, to be offered as a reward for the best plans for using the water-power, and for transmitting the power to Buffalo for use in the factories of that city.

If the money be secured—and it seems probable that it will be—there will be no lack of plans offered to secure the reward, and the persons who are to make the decision will have no easy task. A much better way to apply the money would be to employ one or two competent engineers of good standing to prepare plans and estimates for the work.

THE London *Engineer*, speaking of the proposed Russian oil-pipe line from Baku to a port on the Black Sea calls it "a novel engineering work," and says: "It is yet an engineering question to be solved whether the transmission through the great length of pipe designed can be accomplished in a practically commercial manner."

Apparently the *Engineer* has never heard of the use of pipe lines in this country for transporting oil, or, at any rate, does not know how extensive the pipe system here is, or to what an extent it has taken the oil business away from the railroads. This ignorance of foreign practice is truly British, however, and highly characteristic.

FEW persons except those directly interested realize the extent and value of the Lake Superior commerce, and the number and size of the vessels engaged in it. During the navigation season of 1886 the total tonnage passed through the Sault Ste. Marie Canal, which is the connecting link between Lakes Superior and Huron, was 4,528,000, only about one-fifth less than the tonnage of the Suez Canal. New locks were provided in 1882 to accommodate the growing traffic, but their capacity is already fully taxed, and further enlargement is needed. Work has been begun on a new lock, but it will take several years to build it.

A convention of delegates interested in lake commerce was recently held to advocate further improvements, including the hastening of work on the new locks and the deepening of the channel of the St. Mary's River below the falls and the entrance to the canal. This last improvement is rendered necessary by the increased size of the vessels used in the lake trade. Congress last winter made the first appropriations both for the lock and channel, and the object of the convention was to secure the appropriation of the whole amount required as soon as possible, in order that there may be no delay in the work.

SHIPBUILDING is unusually active in the yards around the lakes, as might be expected after two seasons in which lake vessels have been very profitable to their owners. At Cleveland, Bay City, Detroit and Buffalo there are a number of large vessels building, and new contracts are heard of everywhere.

Several causes have combined to bring about the prosperity which followed a long period of depression, and which has resulted in the present activity in building. The maintenance of rates by the railroad lines at a higher point than had prevailed for several years had a considerable effect; the growth of grain shipments from Duluth, due to the increased settlement and cultivation of the country tributary to that port, and the enormous increase in the Lake Superior iron ore shipments also contributed. The result was that, instead of a competition for business so sharp that it was impossible to keep rates on a paying basis, there was a demand for vessels which could not be filled fast enough.

Of course, there is a possibility that the building of new vessels may be overdone, and that the result may be such a surplus of tonnage as has existed on the ocean for several years past, as shipowners know. At present, however, that point does not seem to have been reached, and there is, apparently, room for all the new vessels.

WITHIN a few years there has been a great change in the character of vessels used on the great lakes. The wooden sailing vessels which formerly did nearly all the business have been gradually supplanted by iron steamers and barges with great capacity for freight. The steamer is the more costly vessel to build and run, it is true, but the difference is more than made up by its greater carrying capacity, its greater speed, the certainty and regularity with which its trips can be made, and its ability to dispense with the costly services of steam-tugs at various points.

The use of the triple-expansion engine and high steam pressure have greatly helped the change by reducing the weight of, and the space required for, the engines, boilers and supply of fuel. The modern engine not only requires less fuel for the same power, but it takes less room and leaves more to be occupied by paying freight.

The change in the lake marine has been very similar to that which has been going on on the ocean, and from very nearly the same causes.

THE Paris Metropolitan Railroad will not be built this year, the Chamber of Deputies having failed to pass the law authorizing its construction, although the plans had been completed and every thing was in readiness. The law was defeated, we are told, by the jealousy of the country members, and their reluctance to appropriate money for the benefit of the capital, although the Parisian deputies were all in favor of it—which reads somewhat like an extract from New York legislative proceedings.

CAR-HEATING in Massachusetts has been placed under the control of the Railroad Commission by a law which forbids the use of any pattern of heater which has not been approved by the Commissioners. In this case the Legislature has acted wisely, for the past history of the Commission is a guarantee that the discretion which the law allows it will be exercised with care and discrimination.

SOME trouble has been caused on the *Atlanta*, it is said, by the defects in the carriages on which the heavy guns are mounted. No particulars have been made public, but it would seem that the provision made for taking up the recoil is not sufficient, and that the reaction on the ship itself has been too great. A Board of Officers is to consider what should be done to remedy these defects. The *Atlanta* is the first of the new cruisers to go into commission, and it is to be regretted that there should be trouble at the start; probably the matter can be remedied without serious difficulty.

OIL FOR FUEL.

THE use of oil as fuel has been very attractive to a class of inventors who shun exact scientific knowledge, apparently for fear that it may prejudice their minds and disincline them from entertaining some of the brilliant ideas which they are pleased to contribute for the advancement of mankind. Other persons, who are not inventors, often ask the question why petroleum can not be used successfully as fuel, especially for locomotives. It has not been easy to satisfy these two classes of people that, ordinarily, you can buy more heat for a dollar if you buy coal than if you buy oil. It is, therefore, gratifying to be able to refer to reliable experiments which have been made to show the relative economy of oil and coal as fuel. Such a series of experiments have recently been made on the Pennsylvania Railroad, and they show very clearly the conditions under which oil may be used as fuel.

By way of explanation, it should be said that Mr. Thomas Urquhart, a Scotchman by birth, and who has for some years been Locomotive Superintendent of the Grazi-Tsaritzin Railway in Southeastern Russia, where there is little other fuel excepting oil, and what there is is dear, whereas oil is plentiful and cheap, has developed the first successful scheme of using petroleum as fuel—at least, in locomotives. Last year, while a representative of the Pennsylvania Railroad was in Europe, he received instructions to go to Russia and learn all he could of Mr. Urquhart's system of burning oil. On the

return of the representative who was sent there, the Pennsylvania Railroad Company determined to apply the Urquhart system to a locomotive. This has been done, and careful experiments have been made with it since.

The plan, as applied here, is shown by figs. 1 and 2. Fig. 1 is a longitudinal section of the fire-box of the locomotive. As shown in the engraving, a fire-brick wall, *W*, is built up at the front end of the fire-box, with sides, *S*, and an arch, *R*, on top. The arrangement of the ash-pan is shown clearly in the engraving. The oil is fed into the fire-box by means of a form of injector shown at A, in fig. 1. The one used in the Pennsylvania experiment is a modification of that shown in section, on an enlarged scale, in fig. 2, which is copied from the drawing of that used by Mr. Urquhart. It consists of a central tube, *T*, to which steam is admitted by a pipe, shown by dotted lines at *B*. The steam enters the annular recess *c c*, and from it, through the holes *d d* passes into the tube *T*. Oil is supplied through the pipe A. When the tube *T*, is withdrawn, by the mechanism shown, it leaves an annular space around it at *e e*, through which the oil is drawn by the action of the current of steam in *T*.

The nozzle *H* of the injector or burner is inserted into a hollow stay-bolt, *K*, in the back end of the fire-box. At *g g* there is an annular opening around the nozzle of the injector. The current of steam and oil which escapes at *H* draws in a supply of air through the opening *g g*. The oil is thus converted into a finely divided spray, which is mixed with the air that enters at *g g*.

The object of the fire-brick is to receive the particles of oil that are not consumed when they are first injected into the fire-box. The shape of the fire-brick structure is that of a bonnet, with its opening turned toward the injector. It thus acts as a combustion chamber, which becomes heated to a very high temperature, and radiates heat to all parts of the fire-box, and also re-ignites the oil after it has been shut off.

In applying this apparatus to an American locomotive, considerable modification was required to adapt it for use here. The difficulties which were encountered have apparently all been overcome, and the engine to which it has been applied has now been in successful use for some time.

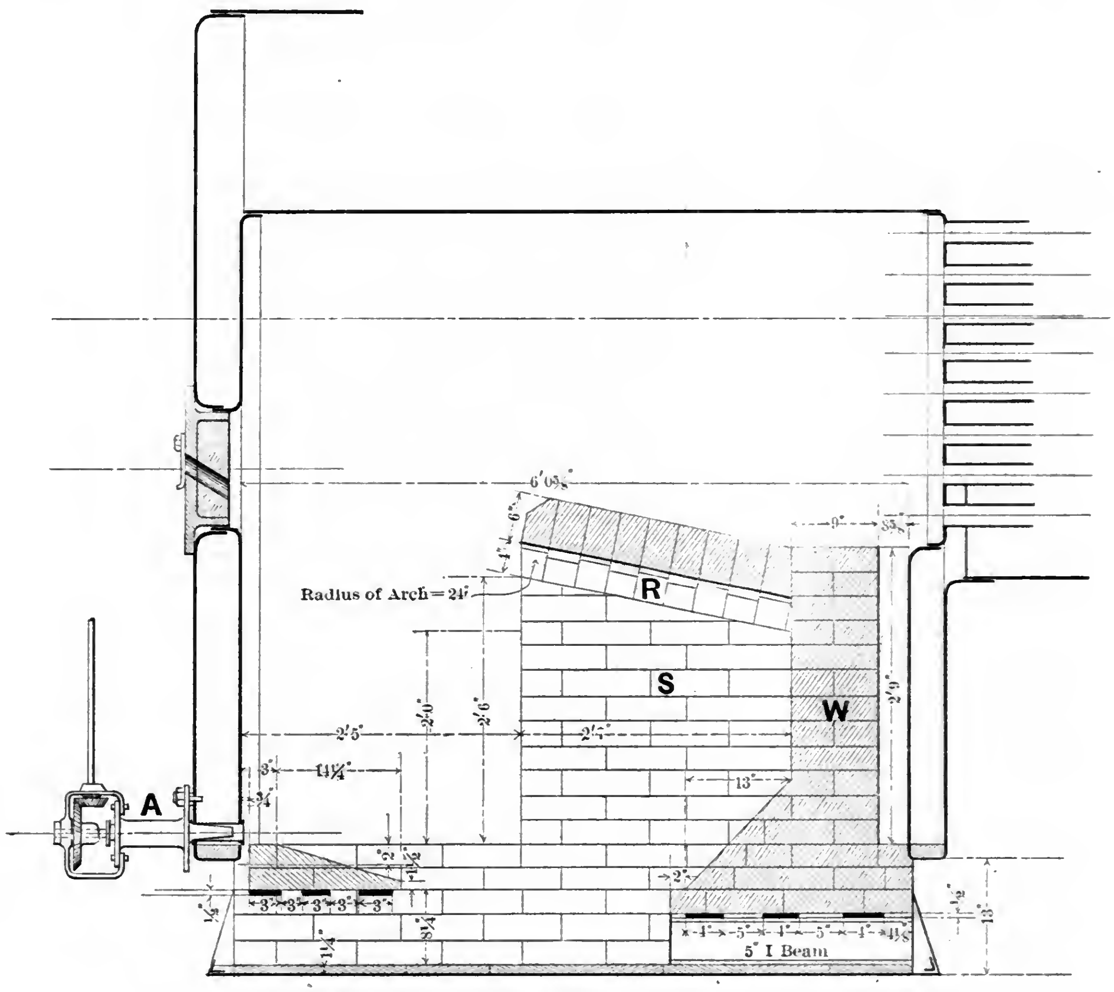


Fig. 1.

Of its working, it may be said that its fuel is smokeless and cinderless. The firing consists simply in the manipulation of a hand wheel, which regulates the supply of oil.

On the Grazi-Tsaritzin Railway, there are now 143 locomotives burning petroleum with the apparatus described. This fact and the experiments on the Pennsylvania Railroad show that the practical difficulties of burning petroleum have been overcome. The only question which remains is that of the relative economy of oil and coal.

Carefully made experiments and the chemical compo-

sition of both coal and oil show that the heat-producing power of a pound of petroleum is equal to that of 1¾ pounds of coal. If the saving due to the cost of handling fuel and ashes, and the diminished repairs to the fire-boxes of locomotives, is taken into account, it is found that *one pound of oil is equal in value to two pounds of coal.* A gallon of oil weighs 7.3 pounds, and a barrel contains 42 gallons. From these data it is easy to calculate the prices at which coal and oil are equally cheap.

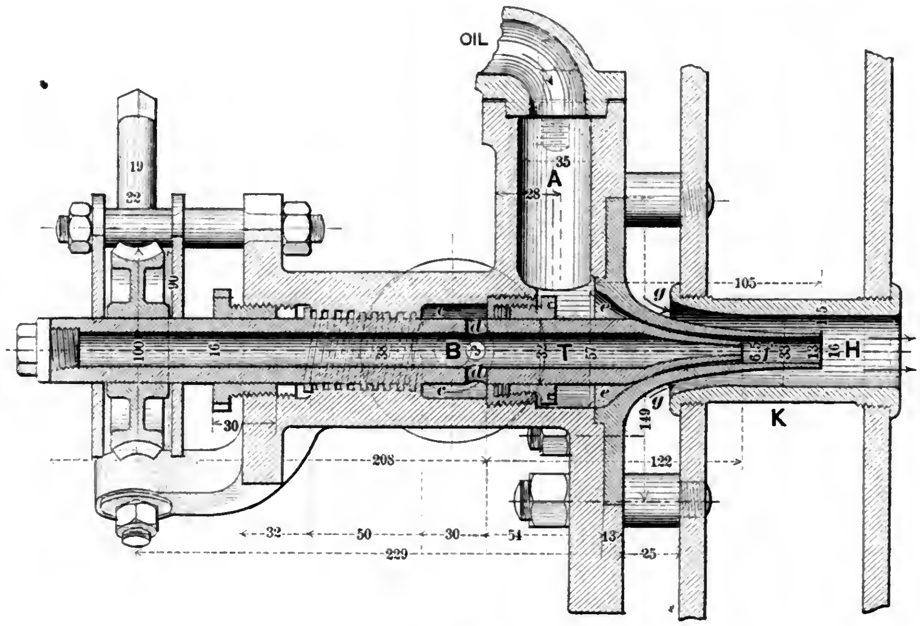


Fig. 2.

(Dimensions in Millimeters.)

The following table has been calculated in this way:

Price of Coal per Ton.	Price of Oil per Bbl., to be as Cheap as Coal.
$2.50	68½ cts.
2.75	75½ cts.
3.00	82½ cts.
3.25	89½ cts.
3.50	96½ cts.
3.75	$1.03½
4.00	1.10½
4.25	1.17½
4.50	1.24½
4.75	1.31
5.00	1.38

This showing does not look very promising for the general use of petroleum for fuel in this country, as any considerable demand from this source would undoubtedly put the price up, unless the production is largely increased over what it is now.

Charles T. Parry.

Mr. Parry, whose death occurred at Beach Haven, New Jersey, on July 18, was the next to the oldest member of the firm of Burnham, Parry, Williams & Co., the proprietors of the Baldwin Locomotive Works. He was born in the City of Philadelphia, on September 15, 1821, and was therefore nearly 66 years old at the time of his death. He was taken sick last November, and since then has been a great sufferer from the disease from which he died. This was an abscess in the region of the spine.

In 1836, he entered the Baldwin Works as an apprentice in the pattern shop. After serving his time, he worked as a journeyman for some years, and then went into the drawing room. In 1854, he was appointed Superintendent of the works, and he at once began to organize the system of doing work which has made this establishment famous the world over. He remained in the service of this company until his death, and he, more than anyone else, created the mechanical reputation of this, the largest locomotive works in this country.

In 1867, he and Mr. Burnham bought Mr. Baldwin's interest and became partners in the firm of M. Baird & Co. Afterward, they bought Mr. Baird's interest, and the firm was then reorganized under its present name.

Mr. Parry had charge of the shops, and superintended the manufacture of locomotives. He took little part in the purely commercial part of the business, but left that to the other partners.

He took a great interest in those under him, and was a remarkably good judge of men. He had traveled frequently in Europe and was a close observer of what he saw there and elsewhere. A widow, son and two daughters survive him. He shared in the success of the works with which he was connected and has left a large estate.

NEW PUBLICATIONS.

The Economic Theory of the Location of Railways. *An Analysis of the Conditions Controlling the Laying out of Railways to Effect the most Judicious Expenditures of Capital:* By Arthur Mellen Wellington. (New York; John Wiley & Son and *Engineering News*, 1887).

This is a "revised and enlarged" edition of the author's former book, with the same title, published ten years ago. The extent of the enlargement and revision, is indicated

by the fact that the new edition contains 980 pages, instead of 230 in the old, although larger type in the new edition must account for part of the difference in the size of the two volumes.

The title of the book has been frequently criticised. Evidently it is not the theory which is economic but the location, so that The Theory of the Economic Location of Railways would have been better.

The introduction to the book is to some extent similar to that of the first edition. The main idea of the author is that, owing to a mistaken policy on the part of the railroad companies, the location of railroads is made secondary in importance to the construction; the salaries paid to locating engineers are relatively small, and consequently the class of work done is of inferior quality, as all first-class engineers get out of location as soon as possible; the majority of the railroads in the United States are most uneconomically located, and that the engineers of the present day are more given to copying the errors of the earlier engineers than to exercising habits of close observation, etc.; and that too much prominence is given by engineers, and by those who teach them to the petty details of how to build the separate structures which make a railroad, to the neglect of the larger questions of where and when to build or whether to build at all.

Part I. Chapter I.—"Inception of Railway Projects." The author here lays down the following rule, which is his guide through the whole book.

"That excepting when and as specific reasons to the contrary appear, the cheapest line is to be built over which it is physically possible to carry the probable traffic with proper safety and speed, using to this end any grades and curves and length of line, which may be most conducive to this end only—and never abandoning it by increasing the expenditure, unless the investment—not the investment as a whole, for the line as a whole, but each particular investment for each particular purpose at each particular point—will be in one way or another profitable in itself." It will be well for each reader to get a thorough understanding of this rule—if he can—not only that he may better understand the book, but in order that he may apply the rule to his work.

The question of probable future profit and loss is there fully discussed.

Chapter II.—"The modern railway corporation, what it is, how organized and managed, both as to its financial and commercial standing," is explained.

Chapter III.—"Causes Modifying the Volume of revenue."

This is devoted principally to the effect upon traffic that the station facilities have.

The distance of the station from the business center of towns. It is well shown with what ease the future of a railroad company may be ruined by a false economy, in placing the station at some distance from the business center, and how vastly this danger is increased, where competitive lines are possible as they are in most cases. Many examples are given of the large sums of money which have been economically spent in effecting convenient station facilities for both the shipper and railroad company, by the leading roads in our large cities.

Chapter IV is devoted to the probable amount of future traffic, and contains some most instructive tables as to the growth of railway business in the past in different countries.

Chapter V.—"Operating Expenses." The operating expenses are carefully separated from the other expenses, and then examined with great care and detail. Valuable tables are given of the actual expenses of different railways. The basis of all the calculations is the *Train Mile.* The operating expenses are assumed to be per train mile, which is very near the actual fact, and then upon this basis we have Table 80, page 179, which gives the actual expense on the per cent. of each item of the operating expenses.

Part II. Chapter VI.—"The Relative Importance of Minor Details of Alignment." Making clear the distinction between the minor details and those of more importance. These minor details are divided into distance, curvature and rise and fall, and the changes to be considered are not enough to affect the train load, but simply affect the cost of hauling it.

Chapter VII.—"Distance." The principal idea is that an increase of distance has a credit side as well as a debit side.

The increase of expense may be very small and in many cases the revenue increased more than the expense.

Chapter VIII.—"Curvature." Gives the various objections to curvature, among them objection No. 8. "It impresses the imagination of travelers with danger even if none exists, and thus affects travel unfavorably."

The other objections are much more real. There are many interesting tables, showing the grades and curvature on many of the railroads in the United States, which are followed by quite an exhaustive treatise upon the mechanics of curve resistance. In this is shown and fully explained the actual position that the four wheels of a truck assume, relative to the track in passing round a curve. This position of the wheels, as shown by the author, being entirely different from what has been in the past considered the correct position, and the proofs of its correctness being the results of original experiments by the author, adds to the interest of this point.

The effect of curvature on expenses is taken up in every detail.

Chapter IX.—"Rise and Fall." After making clear the distinction between rise and fall as here considered and the ruling grade, the author plunges at once into the "Effect of Velocity," as to the difference between the virtual profile and the actual profile, and he certainly has acquired enough personal velocity to carry him over the difficulties of the subject, and as this is a subject upon which very little has been written, and the great value of which very few engineers appreciate, it will well repay the most careful study.

Part III. Chapter X.—Explains clearly the relative importance of minor and ruling grades.

Chapters XI and XII are devoted to the locomotive engine and rolling stock. The great value of these chapters is not so much perhaps in the text as in the numerous and valuable tables of reference, which cannot be found in any other one book.

Both subjects, however, are presented in a more elaborate manner, than in any existing work on railway location.

Chapters XIII, XIV and XV treat respectively of train resistance, the effect of grades upon train loads, and train loads upon operating expenses.

All these subjects are taken up in much detail.

Chapter XVI.—"Assistant Engines." This subject is handled in a masterly manner, and, together with the

chapter of the "Effect of Velocity and Momentum on Grades," presents more original ideas than any other part of the book.

They are subjects of which the generality of engineers know very little and give very little thought, and a thorough study of these chapters will undoubtedly do more to modify future grade lines and lessen operating expenses than all the other chapters of this book.

Chapter XVII.—"The Balance of Grades for Unequal Traffic" presents very little that is new except some tables.

Chapters XVIII and XIX are devoted to "Limiting Curvature" and the "Effects of Sharp Curvature."

Chapter XX, to the "Projection of Low Grades and Pusher Grades" and the "Reduction of the rate and cost of High Grades." In the case of the example of the reduction of the rate of high grades, of the location of the Pacific Branch of the Mexican Central Railway from Lepic to San Blas, there was a second location made through the Barranca Blanca the year following the location made by the author, the plan of which is given on pages 676 and 677. The last location left Lepic, and, following the general line of the highway to Fortuna and from there to near the south end of the Barranca, it entered the Barranca with a small cut, crossed it on a pile of moderate height, turned to the north, and following this side of the Barranca, joined the old line at the point where it (the old line) ran out of the Barranca.

This new line had about 800 degrees less of curvature than the old line, had no higher rate of grade, and was about 3 kilometers (1.8 miles) shorter. The cost of construction on the whole line was very much less, and it did away with the high trestle and spirals.

The fourth reason given for the first location, page 678, is "a dull, uninteresting ride would have been substituted for one of the greatest scenic attractions. A chief dependence for the traffic of the Pacific Branch (and for the main line of the Mexican Central Railway as well) being tourist traffic, and much of the remainder of the line being of great scenic beauty, this alone was deemed a decisive consideration," is directly contradicted by the author in his objections to curvature number 8, page 243; also, the "moral effect" of the shorter line is in its favor.

The traffic of the Hacienda de la Escondida, and that due to the water-power of the River Lepic, would not, by any means, have been lost, but would have come to the railway. The difference in scenic effect is very little, as the only view of any grandeur is obtained just where the line enters the Barranca, and was as fine from one line as the other.

Part IV. Chapter XXVI.—"Trunk Lines and Branches." This treats principally of the increment of traffic due to increasing of the number of traffic points reached, and which of these points should be reached by the main line and which by branch lines.

Chapter XXII.—"Light Rails and Light Railways." Treats principally of the false economy in buying light rails. That the amount of money saved in using light rails in the place of heavy ones goes a very little way toward construction, while the loss to the railroad company by the use of the light rails is tremendous in every way.

That the true place to save money on a light railroad is in the fitting the line to the ground by the use of sharp curves and steeper grades, and not by cutting down the rail section.

Chapter XXIII.—"Economy of Construction." Treats of the many expedients which can be used in the construction when extreme economy is necessary, in order that, when it is desirable to raise the road to first-class, very little of the original cost will have to be wasted, and that the location will be everything that it should be.

Chapter XXIV.—"Improvement of Old Lines and the Virtual Profile." As this subject is becoming of more importance every day, and as this is the most elaborate treatise on it.

Chapters XXV and XXVI.—"Grade Crossings and Interlocking and Terminals." These subjects also becoming daily of more importance, increase the value of the treatment they here receive. There are also some valuable tables concerning some terminals as they actually exist.

Part V.—"Conduct of Location." This commences with the art of reconnoissance, which is justly claimed to be by far the most important part of location. "The worst errors of location generally originate in the reconnoissance." With proper attention to the rules set forth, and close study in each particular case, there should generally exist no necessity for running but on general line. This line, of course, must be fitted in detail to the ground.

The remainder of the book is taken up with hints and rules for engineers on actual location.

The subject is taken up with so much detail, that scarcely a question can arise of which the answer cannot be found in this Part V. It is particularly good in the instruction given in regard to maps and topography.

Appendix A is a well-written description of some experiments of the resistance of rolling stock conducted by the author.

Appendix B is a description of a series of experiments, and their results, with a new apparatus on journal friction at low velocities by the author.

Appendix C. A paper on "the American line from Vera Cruz to the City of Mexico, with notes on best methods of surmounting high elevations by rail, including plan and profile of the line."

And last but not least is an elaborate index, by means of which the book, as a reference, is vastly increased in value.

Taking the book as a whole, no book that has yet been written on the same subject can in any way compare with it.

As a text-book, or a book for students, it should be used with great care. But there is this great thing in its favor, that if any one doubts the correctness of the conclusions and rules, as stated by the author, he has only to take the same data which the author used, and which is all given in the book, and work out his results to suit himself.

BOOKS RECEIVED.

THE GRAPHICAL STATICS OF MECHANISM: BY PROFESSOR GUSTAV HERRMANN; TRANSLATED AND ANNOTATED BY A. P. SMITH, M.E. New York; D. Van Nostrand, 23 Murray street.

CINCINNATI BRASS WORKS CATALOGUE: 1887. Cincinnati, Ohio; F. Lunkenheimer, Proprietor.

SCIENCE. New York; the Science Company. This very excellent and valuable weekly begins its fifth year by adopting a new form and reducing its subscription price to $3.50 yearly. In its new form the page is about the same size as that of the JOURNAL. The quantity of reading matter is the same as in the old form, with the smaller page. Our contemporary will, we hope, secure the increase in circulation which it deserves.

PRINTING MACHINERY: BY EDWARD ARNOTT CLOWES. London, England; published by the Institution of Civil Engineers.

THE TREATMENT OF GUN STEEL: BY COLONEL EARDLY MAITLAND, R. A. London, England; published by the Institution of Civil Engineers.

THE MAVERICK NATIONAL BANK MANUAL: 1887. Boston; published by the Maverick National Bank. This is a manual of Government, State and other securities, issued for the use of investors and giving much useful information.

LIGHT, HEAT AND POWER. Philadelphia, No. 413 Walnut Street. With the issue of July 1 this journal changes from a monthly to a semi-monthly, published on the 1st and 15th of each month.

THE FRACTURE OF RAILWAY TIRES: by WILLIAM WORBY BEAUMONT. London, England; issued by the institution of Civil Engineers.

EXPLORATIONS ON THE WEST COAST OF FLORIDA AND THE OKEECHOBEE WILDERNESS: BY PROFESSOR ANGELO HEILPRIN. Philadelphia; published by the Wagner Free Institution of Science. This is Volume 1 of the *Transactions* of the Wagner Institute, and forms a valuable contribution to the geological and zoological knowledge of a region heretofore little known.

MECHANICAL DEFECTS OF OUR RAILROADS: BY CHARLES W. FELT. Northboro, Mass. Mr. Felt proposes a very startling change in our railroad system, and engineers will read his pamphlet with curiosity, if not with approval.

THE FISHKILL CORLISS ENGINE. Fishkill-on-Hudson, N. Y.; issued by the Fishkill Landing Machine Company. This is a very neat and complete catalogue of the engines, boilers and machinery made by the well-known shops of the company whose name is on the title-page.

THE DURHAM SYSTEM OF SCREW-JOINT IRON HOUSE DRAINAGE. New York; issued by the Durham House Drainage Company.

OBITUARY.

JAMES S. MCENTEE, an old civil engineer, died at his home in Rondout, N. Y., June 30, aged 87 years. He served as Assistant Engineer on the Erie Canal and on the Union Canal in Pennsylvania. Later he was employed on railroad work, both as engineer and contractor, and built sections of the Hudson River road. He made the surveys and located the Rondout & Oswego (now the Ulster & Delaware) road. He retired from business some years ago.

Mr. J. BRUEN MILLER, who died at Newton, N. J., July 3, aged 29 years, was a young man of much promise, and his early death from consumption will be mourned by many friends. He was a resident of Newark, N. J., and for a number of years had been engaged in newspaper work. He was connected with the AMERICAN RAILROAD JOURNAL as editor for about three years, and left it in July, 1886, on account of ill-health.

CAPTAIN SAMUEL P. GRIFFIN, formerly of the United States Navy, died at Aspinwall (Isthmus of Panama), July 4, aged 60 years. He graduated from the Naval Academy in 1841 and served through the Mexican war. In 1849 he commanded the brig *Rescue*, which took part in the Arctic expedition of that year. During the last war he served in Louisiana. For some 20 years past he has been in the service of the Pacific Mail Steamship Company. He was a high authority on navigation and shipbuilding, and his opinion was sought for by many shipowners.

PROVANCE MCCORMACK, who, with James Campbell, in 1841 established the first coke oven and made the first coke in this country, died June 21, at Connellsville, Pa., aged 88 years. He was a grandson of Colonel William Crawford, the first settler in that part of Pennsylvania. Mr. McCormack made a large fortune in various business enterprises, but the great failure of B. F. Bear, a few years ago, ruined him, and when he died he was dependent for a living on the small fees derived from his office of Justice of the Peace.

CHIEF ENGINEER HENRY LEE SNYDER, United States Navy, died in Washington, June 30, aged 50 years. He was born in Pottstown, Pa., and entered the Navy when 21 years old. He rose gradually to the rank of Chief Engineer and stood high on the list of officers of that rank. For several years past he has been detailed as Superintendent of the State, War and Navy Department Building in Washington.

M. M. GREENE died in Columbus, O., June 26, after a short illness; he was 57 years old. He was born in Vermont, and, after serving on the Vermont Central road, went into business as a contractor. In 1867, he was appointed Vice-President and Chief Engineer of the Columbus & Hocking Valley Railroad. In 1874, he became President of the company and retained that office when the present Columbus, Hocking Valley & Toledo Company was formed by consolidation. In 1881, he resigned on account of ill health and retired from business.

O. B. FILLEY, a prominent figure in the industrial community of St. Louis, died at Richfield Springs, N. Y., whither he had gone in quest of better health. Mr. Filley was 51 years of age and had for 25 years past been identified with the iron industries of St. Louis. He was for many years Secretary of the Fulton Foundry Company, and at the time of his death was President of the Missouri Furnace Company, a director in the Joliet Steel Company, the St. Louis Malleable Iron Company and Third National Bank, besides being a large stockholder in the Granite Mountain Mining Company. Mr. Filley was personally popular among the iron men.

WILLIAM WALLACE, who died in Buffalo, N. Y., June 20, aged 82 years, was born in Scotland and came to the United States in 1832. He was an engineer and surveyor by profession and was employed in the building of the old Attica & Buffalo road, and was Superintendent of that line for some years after its completion in 1842. He was Chief Engineer of the Attica & Hornellsville line and afterward of the Buffalo & State Line road. He was the first projector of the line which was afterward built as the Buffalo, New York & Philadelphia and made the original surveys for that road. He retired from business several years ago on account of increasing age.

CHRISTIAN E. DETMOLD died at his home in New York, July 2. He was born in 1809 in Hanover, where he was educated at a military school. He came to this country in 1835, and adopted the profession of a civil engineer and contracter. He built the old Charleston & Hamburg Railroad in South Carolina, one of the first railroads in the country, and later was engaged in constructing canals in Maryland and Pennsylvania. He also built the Crystal Palace in New York in 1853. He was for many years the owner of a large coal mine in Pennsylvania, and in this business amassed a large fortune. Between 1842 and 1850 he gave much attention to the introduction into this country of Faber du Faur's method of utilizing furnace gases in heating the blast. About 15 years ago Mr. Detmold went to Paris, where he lived until within a few years. He married Miss Phœbe Crary and had two daughters, both of whom are married. His wife and daughters survive him.

JACKSON BAILEY died at his residence in Brooklyn, N. Y., July 7, aged 40 years. He was born in Schenectady, N. Y., served in the army when still a boy, and afterwards graduated from the State Normal School at Albany, N. Y. After teaching for several years, he connected himself with a New York publishing firm for a short time, and then became Eastern representative of the *American Manufacturer*, of Pittsburgh.

In November, 1877, he joined Horace B. Miller, under the firm name of Miller & Bailey, in establishing the *American Machinist*. The paper was successful from the start, and Mr. Bailey retained his connection with it up to the time of his death, though his failing health during the past two years had, during a considerable portion of that time, rendered him unable to do active work. His disease was of malarial origin and developed into consumption of the bowels. He leaves a widow, but no children.

At the time of his death Mr. Bailey was First Vice-President of the New York Press Club and a member of a number of engineering societies. He was one of the founders of the American Society of Mechanical Engineers. He was a quiet, unassuming man, but won the esteeem and confidence of those who knew him by his uprightness and the thoroughness of his work.

COLONEL A. A. TALMAGE, General Manager of the Wabash, St. Louis & Pacific lines, died June 28, at Peru, Ind., while on his way from St. Louis to Toledo in his private car. He had suffered from chronic diarrhœa for several months. He was born in Warren County, N. Y., in 1834, and received a substantial elementary education. When had reached the age of 15 he became a clerk in a general merchandise store at Goshen, Orange County, N. Y., where he remained two years. At the age of 18 he was employed in the freight department of the Erie Railroad, and soon attracted attention by his quick apprehension of economical methods of despatching railroad business. In 1858, he went to Chicago in the interests of the Michigan Southern Railroad. He was placed in charge of the business of that company at Monroe, Mich., and subsequently at Toledo, O. When Mr. Talmage was about 25 years old he became a passenger conductor on the railroad. In 1864, he was appointed Assistant Superintendent of the line from East St. Louis to Terre Haute. He resigned this charge in October of the same year on receiving the appointment of Master of Transportation for all the railroads under Government control south of Chattanooga. He was very soon made Superintendent of the same lines, and remained in that important position till the military power turned over the lines to the companies after the close of the war. For some time thereafter he was General Superintendent of the East Tennessee & Georgia Railroad.

In 1868, when the St. Louis, Alton & Terre Haute Railroad had been leased by the Indianapolis & St. Louis Company, he resumed the duties from which he had resigned in October, 1864. In October, 1870, he was appointed General Superintendent of the road. In March, 1871, he was appointed General Superintendent of what was then known as the Atlantic & Pacific Railroad. In December of the same year the general superintendence of the Missouri Pacific Railroad was intrusted to him, and for a period of years he remained in active charge of that very important system. He was the originator of a plan for railroad hospitals to be supported by an assessment on the wages of the employés. When the Wabash passed under Missouri Pacific control it was placed under Colonel Talmage's charge, and when the lines were separated again he remained with the Wabash, and continued to manage its lines Colonel Talmage was considered a manager of great ability.

ALFRED KRUPP, the distinguished metallurgist and manufacturer, died at his home in Essen, Prussia, July 14, aged 75 years. The great steel works at Essen were founded by Friedrich Krupp in 1810 as a small forge, employing only two workmen, and continued to grow under his management until the date of his death, in 1826, when Alfred Krupp, his son, was only 14 years old. From 1826 to 1848 the works were carried on by the widow and sons in company, Alfred displaying a phenomenal aptitude for the business and remarkable executive ability. In 1848, Alfred Krupp, whose death is now announced, took entire charge of the works, and carried on the business under the firm name of Friedrich Krupp, and to him is due the credit for the establishment of these, the most extensive, and in some respects the finest works in the world.

The discovery which had most effect upon them, was that of a way to cast steel in large masses, an unsurmountable task prior to Krupp's experiments. He signalized his discovery by sending to the London Exhibition of 1851 a block weighing 45 German quintals, which at that time was a great curiosity. General attention was then called to the works and their business rapidly increased. Herr Krupp was among the first to adopt the Bessemer process, and rapidly extended its use. Guns, armor-plates, rails, tires, and many other articles of Krupp make are to be found in all parts of the world.

Engineers are chiefly interested in the many improvements introduced by Herr Krupp in the treatment of iron and steel. His were among the very earliest works to adopt any new process which promised well, and several dephosphorizing processes have long been used there. As, however, his works were very jealously closed against visitors, and a secret was made of nearly every thing about them, only general information was allowed to get into print. It is charged that, while Herr Krupp was prompt in adopting every improvement in iron and steel making, he rarely gave credit or reward to the inventor whose improvement he adopted.

The enormous extent of the Essen Works may be appreciated from the following interesting figures with regard to the growth of the establishment which were published in 1884. In 1860 Essen Foundry had only 1,746 workmen, but that number had risen to 7,084 ten years later, and it was in 1884 upward of 20,000. Counting the women and children, Herr Krupp's establishment gave employment in 1884 to 65,381 people, of whom 29,000 lived in houses belonging to their employer. The foundry was divided into eight sections, and there were 11 blast-furnaces, 1,542 other furnaces, 439 steam-boilers, 82 steam-hammers, and 450 steam engines representing 185,000 horse-power. At Essen alone, to say nothing of the branch establishments, there were nearly 40 miles of rails, 28 locomotives, 883 trucks, 369 horses, 191 wagons, 40 miles of telegraph wires, 35 telegraph stations, and 55 Morse instruments. Since then large additions have been made to the works.

Herr Krupp was a model employer; he built excellent houses for his officers and men, hospitals for the sick, established sick, burial and pension funds for his employés, and generally took the warmest interest in their welfare.

The importance of his services and his wealth induced Emperor William to offer him letters of nobility in 1864. They were, however, declined.

Contributions.

THE GEODETIC WORK IN THE UNITED STATES.

VI. THE U. S. COAST AND GEODETIC SURVEY.—CONTINUED.

BY PROF. J. HOWARD GORE.

In the subsequent operations of the Survey, so many skilled observers and able computers have been employed that it is well-nigh impossible to specify to what extent the success is due to them, or how much praise the following superintendents deserve. In this article only a concise statement will be made to show how the methods have been improved, what accuracy has been attained and the amount of work that has been performed.

The primary triangulation, which Hassler's successors have regarded as the mainstay in their plan of procedure, has been so far extended as long ago to suggest its utilization as data in the great geodetic problem. When the importance of this subsidiary feature came to be fully considered, no intelligent person could be found to say that undue refinement had been practiced. Francoeur, in speaking of the methods proposed at the beginning, said: "They prove the work of a very learned and well-exercised engineer, who knows perfectly all the geodetical methods and the methods of observation, who knows their difficulties and defects, and has diminished the causes of error and given to the results all the precision possible."

During the field season of 1844 two bases were measured, one along the Boston & Providence Railroad, in the immediate vicinity of the site Borden had selected for the measurement of his base of verification; this base, nearly 11 miles long, was very rapidly measured, with Hassler's apparatus, on a graded and unobstructed side track. The other was the Kent Island base, on which a modified form of Hassler's apparatus was employed.

The unfavorable conditions for triangulation existing along the coast of the Southern States necessitated more numerous bases, and with this increase in number it was deemed advisable to so simplify the apparatus as to diminish the cost of the work. While this was being done, it was desired to introduce other advantages, such as: That the length of the apparatus be invariable at different temperatures; that the bars have equal absorbent powers for heat; that they be supported so as to be stiffened laterally as well as horizontally, while capable of free motion; that they be enclosed in a way which prevents sudden changes of temperature, the covering also giving stiffness; that the whole be supported at two points only, and easily movable in the different directions required for adjustment in measurement. The general conditions to be fulfilled and a description of the apparatus were given to Mr. Würdeman, the Mechanician of the Survey—his name still being attached to the results of his ingenious skill.

Professor Bache had determined, by a long series of very careful experiments, the relative cross-sections of the bars of iron and brass, which were to constitute a new base apparatus for the use of the Survey, depending upon their difference of specific heat and conducting power, the absorbent qualities of their surfaces being adjusted by the use of different colored varnishes.

This apparatus consists of an iron and a brass bar, firmly united at one end, the brass bar being placed on the lower side. At the opposite end a short lever of compensation is jointed to the brass bar, its polished steel surface being pressed against the end of the iron bar by a spring, which is so attached to a small rod placed parallel to and above the iron bar, that it constantly acts to draw the rod back and the end of the compensating lever with it. The arms of the lever are proportioned to each other as the expansion of iron to brass, or as 1,100 is to 1,748, or very nearly as the expansion given by Smeaton of iron, 0.001258, and by Laplace of brass, 0.00186671.

The lever being proportioned as above stated, when the brass and iron bars are expanded by heat its outer end will not be moved, but will keep exactly its normal distance from the opposite end of the apparatus, where the two bars are fixed together. The expansion of the short iron rod on the end of the lever is allowed for in the arrangement, and it carries on its end a polished agate plate, ¼ in. in diameter, which is the surface of contact at that end of the apparatus. At the other end (where the bars are fastened together) there is a Bessel contact level, with an iron rod acting upon it. By means of a spring, this iron rod is thrust outward, so that, in making contact, the knife-edged agate in which it terminates is brought against the agate plane on the opposite or lever end of another bar of exactly the same size and construction. The bar is then moved gently until the contact level shows a horizontal position, when the distance between the agate surfaces at the fixed and lever ends is the normal length.

This apparatus was first used on the Dauphin Island base, measured in 1847. Here the probable error was found to be about two-hundredths of an inch in a mile; the length had been obtained by comparing six single meters, placed end to end with the apparatus as a whole, while the individual meters were compared with an authentic standard meter—one of those originally made by the French Committee on Weights and Measures. It was brought to this country by Mr. Hassler, and presented by him to the American Philosophical Society.

The comparisons of length were made by means of Saxton's pyrometer, a very simple instrument, but one affording the highest degree of accuracy: "A small mirror, movable about a vertical axis, reflects into the field of a telescope, placed at a distance of 20 ft., the divisions of a long curved scale placed under the telescope; by means of a small abutting piece attached to the mirror, any difference in length to be measured causes a corresponding rotation of the mirror, by which different scale-divisions appear on the wires in the telescope, and a greatly magnified indication is thus obtained by an index equal in length to twice the distance of the mirror from the scale. The quantity is thus readily magnified 2,000 times, without any loss from inertia and flexure, which would be unavoidable in obtaining a similar result by means of mechanical levers."

Ascertaining in this way the exact length of the apparatus, a principal source of error in obtaining the length of the base is eliminated, leaving only errors such as arise from uncertainties in determining the coefficients of the component bars, and adjusting the lever of compensation in the ratio of these coefficients, together with errors that arise in manipulating the apparatus. These

admit of computation, and the sum total of their effect given as the probable error. The following table gives the principal items of interest connected with the measurements of all the bases with the Bache-Würdeman apparatus:

Name of Base.	When measured	Length in miles.	Number of tubes.	Hours employed	Probable error.
Dauphin Island......	1847	6.66	1777	143	1:410000
Bodie's "	1848	6.75	1807	81	1:425500
Edisto "	1850	6.66	1787	97	1:418600
Key Biscayne........	1855	3.6	965	67	1:454400
Cape Sable...........	1855	4	1702	46	1:551600
Epping Plains...... .	1857	5.4	1453	67	1:551600
Peach Tree Ridge....	1872	5.8	1556	84	1:561880

In 1880 it was decided to construct a new apparatus, which would be simpler in construction, but would secure all the advantages found in the Bache-Würdeman. First of all, it was decided to have the length five meters, instead of six. The measuring-bar is composed of two metals, so proportioned as to be compensating for changes of temperature, and rigidly connected, but without any points, levers or movable parts, which not only complicate the construction, but also introduce sources of error in the unequal wear of the different parts. In this form there is a large bar of zinc, and fastened near each end is a steel bar, extending in a direction towards the opposite end, thus forming three parallel bars, on the gridiron principle. The expansion or contraction of the zinc bar is exactly counteracted by the expansion or contraction of the two steel bars, but since the coefficient of expansion of zinc is about 2¾ times that of steel, the zinc bar is necessarily the shorter. In order to secure the bars against the differential expansion that might arise from incorrect proportionment of the size and length of the component bars, the zinc bar is allowed to project beyond the points of attachment, where, in connection with the accompanying steel bar, a Borda scale is applied. Mercurial thermometers were also provided. The "Mudge" contact-slide was employed, instead of the complex contact-level. The only base measured with this apparatus was the Yolo base, in California.

In this instance, the bars during measurement were protected from the action of the sun by an awning made of sailcloth, placed on wheels, so that it could be moved as the work progressed. Twenty-four men were employed 408 hours in the actual measuring of 8,494 bars, which represented two entire measurements and a segment of somewhat more than the entire line. The length obtained is 17,486.51193 meters, with a probable error, equivalent to $\frac{1}{1327200}$ of the length. In this apparatus, authenticated temperature changes were not always accompanied by corresponding indications of the Borda scale. In short, the behavior of the zinc component was so unsatisfactory that a new apparatus is under consideration, in which the scale readings will be omitted, and either a partly compensated pair of bars or a single, carefullly protected bar of steel adopted instead, with very frequent comparisons with a field standard.

The triangulation of the Geodetic Survey is in keeping with the base determination. It is divided into primary and secondary, the difference being based upon the length of sides rather than difference of precision. The angles are measured with great care, the maximum error allowed is 0″.3, while the average falls below 0″.15, and in Nevada and California it is still less. An idea of the accuracy of pointing and reading can best be formed when it is stated that the greatest error made in determining the position of a signal is less than the radius of the object observed. The average error in closing a triangle has varied between 0″.25 and 1″.25, irrespective of size.

Great improvements have been made in theodolites; hard metal has taken the place of soft metal, and they are constructed with stronger frames than formerly. The optical power of the telescope is increased and the focal distance diminished, the former in conformity with the increase in precision of the graduation, which also allows a general diminution in size of other parts of the instrument, the former large circles of 30 miles diameter having given way to those of 20, used at present. The illumination of the field of the micrometer is radial, and the microscopes are rendered more efficient by aplanatic lenses, giving better definition and greater magnifying power. The complex repeating-circles and verniers have passed out of date for all larger instruments. The spokes of the graduated circles have disappeared, and full, thin plates have taken their place, clamps are attached to the axis, and the circle may be shifted in various positions with the greatest ease.

The test of accuracy of both base measurements and triangulation is the difference found in the length of a junction line depending on two primary bases connected by intervening triangulation.

In this connection may be cited the comparison of the Epping, Massachusetts and Fire Island bases: Their distances apart are:

Epping to Massachusetts	295 miles.
Massachusetts to Fire Island	430 "
Epping to Fire Island (direct)	430 "
Epping base measured	8715.962 M.
Derived from Mass	8715.865 "
" " Fire Island	8715.900 "
Massachusetts base measured	17326.376 "
Derived from Epping	17326.528 "
" " Fire Island	17326.445 "
Fire Island base measured	14058.971 "
Derived from Epping	14059.039 "
" " Mass	14058.916 "

Again: Kent Island and the Atlanta bases are separated by 602 miles; from each the common line, Buffalo to Moore, about 29½ miles in length, was computed, giving a difference of only 16 min., or six-tenths of an inch. The difference between the lengths of this line before final adjustment was less than 3 inches.

In the astronomic determination, similar success has been achieved, owing both to the instruments used and the methods of reduction. The results for latitude have gained much in precision by the introduction of more precise star-places (in declination), which has become possible by the introduction of new catalogues and by the recent labors of astronomers, particularly Boss and Auwen, in submitting the catalogued places to systematic discussion. In the telegraphic instruments, short and split electro-magnets, possessing the property of rapid charge and discharge, have been introduced, along with improved chronographs, of great regularity of motion and instantly changeable to double speed when required for exchanges.

This is what the Survey has accomplished: Fifteen bases have been measured, with the success already mentioned; nearly eleven thousand primary stations have

been occupied; the coast triangulation and hydrography extended from Maine to Mexico, with a few breaks; the coast of California, with short stretches in Oregon and Washington Territory, along many navigable rivers, and nearly four-fifths of the transcontinental chain extending along the 39th parallel.

This stupendous work has been oriented by 188 stations for azimuth, and put in its correct place on the spheroid of latitude observations at 300 stations, and longitude at 115, while magnetic observations have been made at nearly 700 places, and gravity experiments made at numerous stations, not only in this country, but also in various parts of the world.

The reductions have also received attention, equally with the field work. To all observations a criterion is applied, and those used are properly weighted. The most advantageous figures are used in first adjustments, and when the triangulation has progressed sufficiently to include another base, the whole is subjected to the rigorous conditions that the co-ordinates of the termini should be the same from direct observation and computation, and that the lengths of all lines be the same when computed from both bases.

In longitude computations, particular attention is paid to the relative weights depending upon: The stars' position, the value of the time determination, the variations in personal equation, and the performance of the chronometers with respect to time elapsed between time determination and the exchange—arbitrary signals being used, instead of automatic.

For its publications, this institution deserves our sincerest thanks; in the annual reports, beginning in 1854 as separate volumes, are to be fonnd thorough discussions of every branch of Geodesy; among them are 22 papers on base-measuring and 25 on field-work and reduction of the triangulation.

If the Geodesists of the world were asked to lay out the future work of the Survey, they would suggest the filling up of that small gap, which, with the excellent work of the Lake Survey, and the Surveys of New York and Pennsylvania, would give a meridional arc or of 8° and of supreme importance they would consider the continuance of the transcontinental belt along the 39th parallel, giving an arc of 46° perpendicular to the meridian. Then, with the adaptability of this country for an arc of a meridian of 16°, we would not be satisfied until its length and amplitude were determined, as well as the lines of level to connect the Atlantic with the Pacific, and the Great Lakes with the Gulf of Mexico.

QUADRUPLE-EXPANSION MARINE ENGINE.

THE quadruple-expansion engines shown in the accompanying illustrations were recently built by Rankin & Blackmore, of Greenock, Scotland, for the *Myrtle*, a vessel used for summer excursion business. The boat is 163 ft. long, 20 ft. 6 in. beam and 14 ft. moulded depth, her registered size being 318 tons. The engines shown were put in to replace an old compound engine of the ordinary type. On the trial trip the *Myrtle* made 12 knots an hour, with a consumption of 1.2 lbs. good Welsh coal per H. P. during a run of three hours.

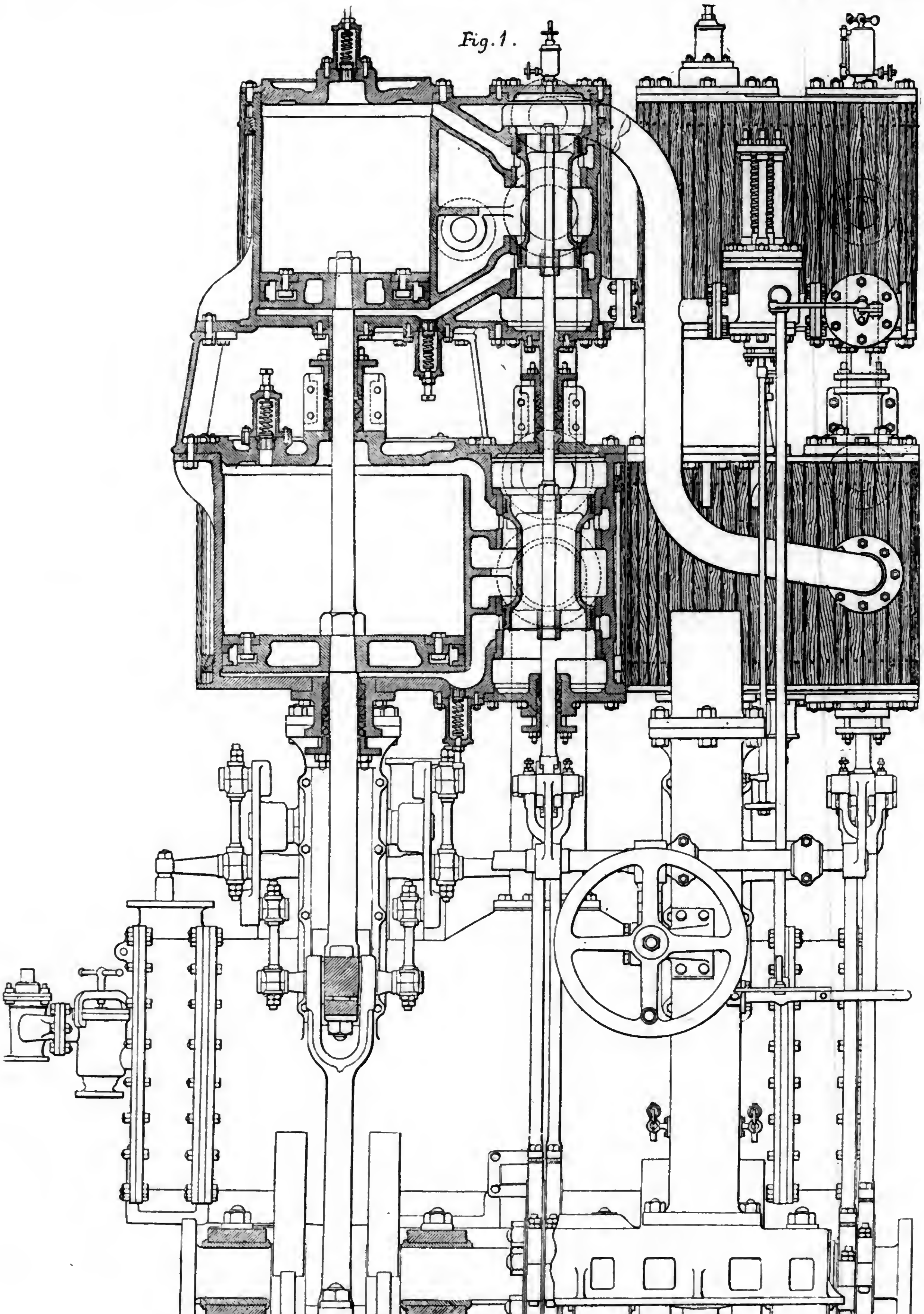
For the illustrations and the following description we are indebted to *Engineering:*

The new engines are of the four-cylinder, disconnected, quadruple-expansion type working tandem on two cranks, patented by Messrs. John F. & Matthew Rankin, and the cylinders are 12 in., 17 in., 24 in. and 34 in. in diameter. all having a piston-stroke of 24 in.

The fact that the quadruple-expansion engines have developed more than double the power of the old compounds, within the same space, is a rough proof of startling significance as to the great economy of room, power for power, effected by the new type, and this is still more strongly accentuated when compared with the three-crank triple-expansion engines with the third cylinder occupying so much useful space fore and aft. The engines of the *Myrtle* are somewhat similar in general design to the four-cylinder tandem type so long and so favorably known in connection with the celebrated White Star and other steamers, while they have, by means of the disconnective arrangement, the same valuable capability of either half being able to work independently of the other in case of need, with the enormous additional advantage of nearly 40 per cent. saving of coal and less initial friction. The only features of novelty lie in the cylinders. Hitherto the principal objections of sea-going engineers against tandem engines have been the annoyance involved in the extra piston-rod and valve-spindle stuffing-boxes, with their troublesome packing and glands; also the difficulty of getting at the lower pistons for examination and overhauling. The former difficulty has been overcome by abolishing the stuffing-boxes on the two upper cylinders and substituting brass-fingered tubes which dip down into the stuffing-boxes beneath on the tops of the lower cylinders, thus doing away with a considerable amount of friction. There is a minor, but still noteworthy, saving of friction in the upper stuffing-boxes, as the Tuck's packing, which is essential to any escape of steam and to impart elasticity to the rigid metallic packing rings, does not come into contact with the rods at all, owing to the interposition of the above-mentioned tubes, so that the trouble caused by the India-rubber cores melting through constant rubbing and adhering to the rods is completely prevented.

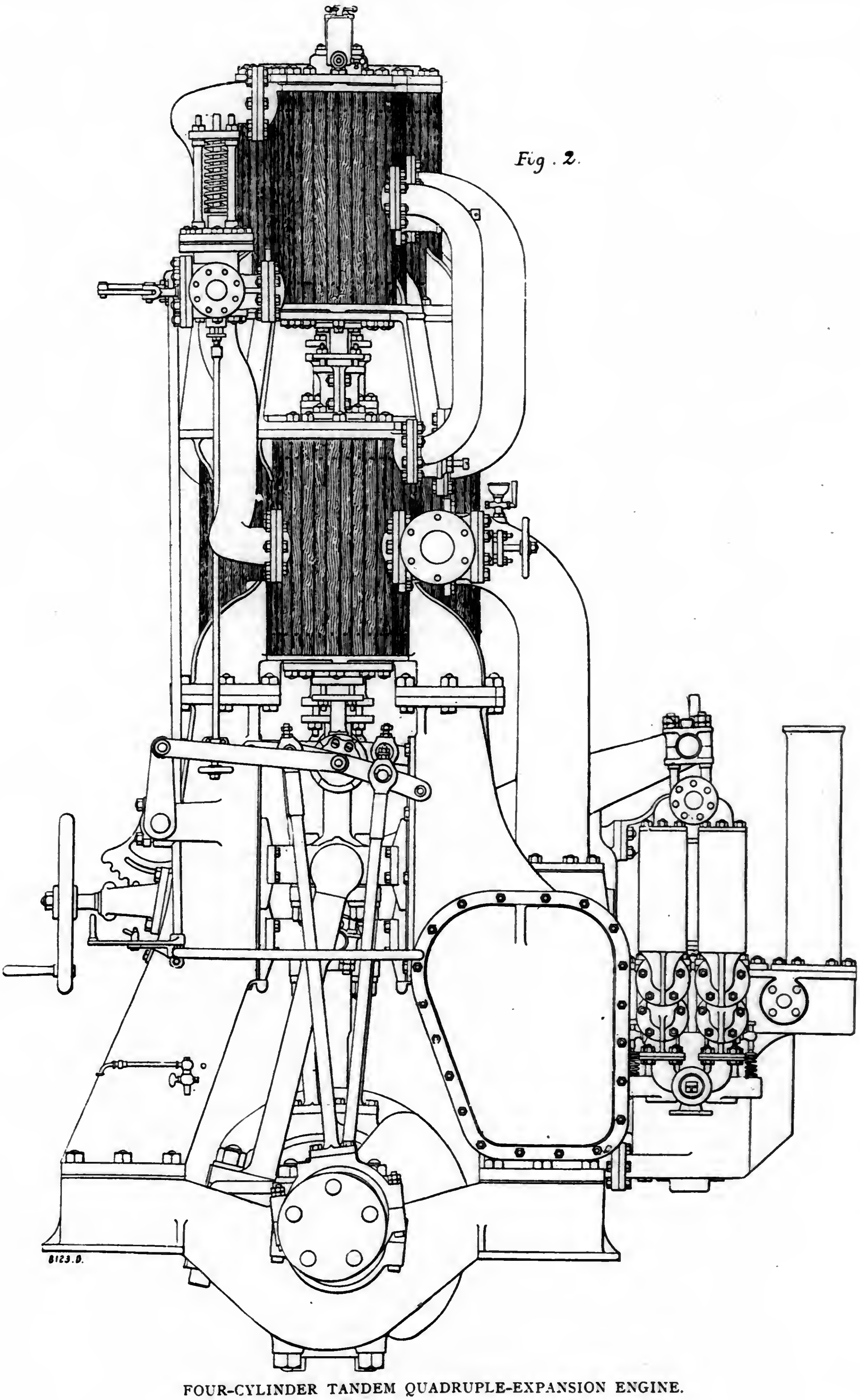
To render the lower pistons easy of access without disturbing the upper cylinders, there are provided shelves formed by extensions of the usual cylinder flanges, to which are bolted the connecting pieces between the upper and lower cylinders, leaving sufficient room for lifting the covers with the greatest facility. In furtherance of this, the stuffing-boxes are bolted instead of being cast on, and they are also made in halves, on removal of which the covers can be raised to that additional extent, leaving in all the space of 16 in., which is ample for all the requirements of overhauling. Even if it should be necessary to take out the pistons, this can be done by removing one of the connecting pieces, which have been made separate for this purpose. With the view of reducing the initial friction of these engines to a minimum, piston valves have been adopted (the upper covers of which are fitted with separate stuffing-boxes made in halves for ready detachment) for all the cylinders, and, as a practical illustration of the resulting benefit derived from their use and the abolition of the upper valve stuffing-boxes, it was found that the reversing wheel was worked with ease, although it was just the same diameter as had formerly proved to be essential for compound engines of only half the power.

The valve-gear consists of the old double-plate link motion made with large wearing surfaces and adjustable bushes, a gear which still seems to hold its own well, in spite of its many rivals. The packing of the piston-valves consists of hard cast-iron rings, while the pistons are fitted throughout with Lockwood & Carlisle's patent rings and springs. As the cylinders have neither boiler nor exhaust steam jackets, the usual ramification of drain piping has been much simplified, and the tandem arrangement has been taken advantage of to lead the hot drain water and steam from the two upper cylinders direct into the two lower ones before going into the condenser, thus shortening the pipes by a good many feet. The condenser presents nothing in the way of novelty save that it looks small in proportion to the rest of the machinery, with its 618 sq. ft. of cooling surface, nearly 50 per cent. less than the usual practice for compound engines, thus



FOUR-CYLINDER TANDEM QUADRUPLE-EXPANSION ENGINE.

BUILT BY RANKIN & BLACKMORE, GREENOCK, SCOTLAND.



FOUR-CYLINDER TANDEM QUADRUPLE-EXPANSION ENGINE.

BUILT BY RANKIN & BLACKMORE, GREENOCK, SCOTLAND.

forming another rough check as to the relative efficiency.

The air and circulating pumps are both single-acting, 14 in. in diameter by $13\frac{1}{2}$ in. stroke; the feed and bilge-pumps are 3 in. in diameter by $13\frac{1}{2}$ in. stroke, all being worked from the crosshead of the low-pressure cylinder by solid forged-iron levers. The boiler has been constructed to suit the Board of Trade and Lloyd's rules for a working pressure of 180 lbs., and is 11 ft. 6 in. in diameter by 9 ft. 6 in. long, with two of Fox's corrugated furnaces 3 ft. 5 in. in internal diameter. The plates were made of specially mild steel by the Steel Company of Scotland, and worked most satisfactorily. The outside shell plates are $1\frac{5}{32}$ in. thick, and were rolled cold to prevent any chance of undue strains being set up by the local heating of such heavy plates.

The boiler has 52 stay and 115 common tubes, $3\frac{1}{2}$ in. in internal diameter and 7 ft. long. The stay tubes are screwed into both tube-plates, and they are the first the makers have used on a new principle, with thickened ends, so that after they are screwed the thickness from the bottom of the threads is the same as the body of the tubes, thus maintaining equal thickness of metal throughout, and presenting more efficient heating surface on account of the thickness of the bodies being reduced from $\frac{5}{16}$ in. to $\frac{3}{16}$ in. The circumferential seams of the boiler are double-riveted, and the longitudinal triple-riveted seams have butted joints with double straps $\frac{15}{16}$ in. thick. The rivets for the outside shell are of steel $1\frac{1}{4}$ in. in diameter; all the holes were drilled in position, a matter of great importance with so heavy a working pressure, and the riveting was effected by a powerful hydraulic machine. A prolongation of the feed-pipe passes nine times across the smoke-box on its way to the upper part of the boiler, so that the feed-water gets the benefit of the waste heat going up the funnel, which, as in most yachts, has been made double.

The propeller is of solid cast-iron, with four blades set aft to diminish vibration, and on the trial trip this was found to be scarcely perceptible. Indeed, it was remarked as a notable fact that the engines worked almost as smoothly as those of the triple-expansion three crank type, which result was attributed to the cushioning afforded by the high-pressure steam of the upper cylinders; to the steam in all the cylinders being carried during a longer portion of the stroke, owing to the extra stage of expansion; to the fact that there are only two sets of valve-gear instead of three, and that all the valves are of the piston kind; and lastly, to the careful counterbalancing of the cranks.

As many shipowners seem to be in perplexity as to the respective merits of triple and quadruple-expansion engines, we have ventured to present the case of the latter at length, and we trust that this will be sufficient excuse for what might otherwise appear undue prolixity. Then there is the considerable saving in the consumption of coal, and this economy will become even more pronounced relatively as the engines become worn, as there are three traps instead of two to catch and utilize any leakage of steam from the high-pressure cylinder. The low-pressure cylinder, which can least afford to get out of order, forms only a fourth instead of a third of the gross power, and consequently will be less affected by a leaky piston or defective pumps. Further, the *Myrtle's* engines have only four sets of valve spindles and piston-rod stuffing-boxes instead of six, as in first-class three-crank triple-expansion engines with the piston-rods passing through the cylinder covers, two sets of valve motion against three, and a similar saving with respect to the piston and connecting-rods and main bearings (which latter will, of course, be less liable to wear out of truth), one starting valve in the place of two, and other minor gains. The only item on the other side is an extra cylinder, but this does not count for much, as, with the additional stage of expansion, the pistons may be made an easier fit, any slight leakage of steam being taken up by the next cylinder, and there is practically no friction with the piston valves, while, as already mentioned, the two stuffing-boxes have been done away with.

With regard to the disconnective gear, before explaining the mode of working, we may point out that the crank-shaft is made in interchangeable halves bolted strongly together to facilitate the uncoupling of the forward engine, if it should happen to break down, or require to be overhauled at sea. Both cranks are loaded with weights to counterbalance the weight of the pistons and rods. The disconnective gear consists of an arrangement of valves and piping, whereby one-half of the engines may be utilized without delay in the event of the other half going wrong. For instance, suppose the high-pressure half to become useless for the time being, the stop valve is closed and steam at about 60 lbs. pressure is admitted to the second intermediate cylinder direct from the boiler through the reducing valve shown on fig. 1 of the engravings, and after doing its work the steam passes through the low-pressure cylinder, which in turn exhausts into the condenser, thus forming an ordinary tandem compound engine, if time permitted of the forward half of the shaft being uncoupled. This, of course, is not absolutely necessary, but would greatly relieve the after engine. If, on the other hand, the low-pressure half should get out of order, the steam, instead of going through the third-stage cylinder, would be led from the second-stage cylinder into the atmosphere, by a connection to the waste steam pipe. In this case, the low-pressure connecting-rod and eccentric-rods should be disconnected if possible. It seems to us that the extreme facility with which either portion of the engine can be handled independently is of special value for a tourist vessel, as affording an extra feeling of security against detention to pleasure seekers whose leisure time may be limited to the brief span of an average summer holiday.

High-Pressure Marine Boilers.

(From the London *Engineer*.)

RECENTLY we pointed out that, so far as the engine is concerned, there ought to be little difficulty in using steam of 250 lbs. pressure at sea. The real obstacle to be feared is the difficulty of constructing boilers which will sustain this pressure and yet be suitable for use under the prevailing conditions. Boiler shells are now made 14 ft. in diameter, of steel plates $1\frac{1}{2}$ in. thick. These shells are intended to carry a pressure of 160 lbs. on the square inch. If the pressure were augmented to 250 lbs. the thickness of the plates must be raised to $2\frac{3}{8}$ in., provided the diameter remained the same; and we have good reason to doubt that any boiler-maker would undertake to make such a shell, and we are quite certain that no plant exists in any part of the world adequate to the performance of the task. It seems, therefore, to be quite clear that, whether the existing type of marine boiler be or be not retained, the existing proportions must be abandoned. Let us suppose that, instead of a shell 14 ft. in diameter containing three furnaces, we have a shell 9 ft. in diameter containing two furnaces 3 ft. in diameter. Such a shell made of $1\frac{1}{2}$-in. steel would be quite strong enough for 250 lbs. per square inch. Yet we are no nearer to the required end, because it would be next to impossible to obtain a furnace tube at once sufficiently thin to prevent over-heating, and sufficiently strong to stand up to 250 lbs. Mr. Fox, by his corrugated flues, made high-pressures possible at sea; but there is a limit, and, so far as the existing drift of engineering opinion goes, the limit for corrugated flues has been reached, if not a little overpassed, at 160 lbs. It may be said that the difficulty can be got over by reducing the diameter of the flue. In one sense this is true; but small furnaces cannot be properly worked at sea. If they are to be adopted, forced draught must also be used, and the shipowner would find himself saddled with not one experiment but several. Contemplating the trial of 250 lbs. steam only, he would find that a totally unusual system of burning coal would have to be adopted, to say nothing of certain incidental minor novelties. The next important step in marine engineering will be the production of furnaces which, not more than $\frac{1}{2}$ in. thick, will carry safely 150 lbs. pressure, and yet be quite suitable for use under ordinary sea-going conditions.

Arrived at this point, we expect to be told that the best solution of the whole difficulty lies in the use of water-tube boilers. To this we demur. We are by no means blind to the good points in, for example, the Root and the De Nayer boilers; but tubulous boilers have been well tried at sea and found wanting. The great objection to them is that for a given power they take up an inordinate amount of space. Their heating surface is inefficient. Seventy square feet of surface in an ordinary marine boiler will make more steam than 100 ft. in a tubular boiler. This ought not to be so. It is contrary to all reason. It is absurd, but though absurd it is a stubborn fact. On land, this is of no consequence; at sea, it is a vital defect. It may be obviated perhaps. Till it is we must deal with things as they are. If, then, the water-tube boiler and the ordinary boiler cannot be used with high pressures, what is to be done? Unfortunately it is much easier to criticise and condemn than it is to suggest a remedy. Two schemes may, however, be mentioned, both of which are at least worth discussion.

A shell of steel, $\frac{7}{16}$ in. thick, double riveted, will sustain a bursting pressure of about 1,100 lbs., so that with a working pressure of 250 lbs., there would be a factor of safety of a little over four, which is sufficient. A boiler might be constructed of such cylinders, fired outside, and would be perfectly safe; because it would be free from all the objctions which are justly urged against externally-fired boilers of the ordinary type. Such boilers have been used, although of very crude design, for many years on the great rivers of the United States. They have, it is quite true, exploded now and then with disastrous results; but such explosions have almost always resulted from racing, or from the use of extremely muddy water without proper precautions. In the hands of modern English engineers nothing of the kind need be apprehended, and there is enough about such a system of construction to make it worth more consideration than it has yet received. Of course, each boiler proper would be built up of a number of sections, each consisting of one tube, 3 ft. in diameter and 8 ft. or 9 ft. long, flanged and riveted to a properly stayed flat-sided chamber, which would at once put all the sections in free communication and provide a portion of the steam place. Something in this direction was done years ago by Mr. Howard, of Bedford, and the experience he acquired might be utilised to make a further advance. A very powerful argument against externally-fired tubes must not be forgotten, however. It is well known that an ordinary furnace crown may come down without any one being killed or even scalded. The overheated metal bulges and stretches, but it does not give way, and even when it does crack so as to permit the escape of large volumes of water, the steam, instead of rushing into the stokehole, finds an exit up the funnel. Unfortunately, there is reason to fear that this would not be the case if an externally-fired cylinder became overheated because of accumulated deposit or other cause. Under these conditions, the overheated plate would give way with disastrous results, unless some special, not very easily devised arrangements were made to insure the safety of the firemen and engineers.

We have said above that two methods of construction suggest themselves. One we have just considered, the other means resorting to, in a sense, the locomotive type. Now, to this, insurmountable objections have hitherto arisen, when it was tried in the merchant service, although it has been very successfully adopted in war ships by both France and Great Britain. But we do not believe that the last word, or anything like the last word, has been said about the locomotive type at sea. One of the great objections urged against it is that a small depth of water is carried over the fire-box crown; but this is not the fault of the system, but of the way in which it has been applied. The good points about the locomotive boiler are, that it permits us to use comparatively small shells containing a great deal of heating surface, and that there is practically no limit to the strength which can be imparted to flat surfaces by staying, so that, consequently, we can have a fire-box or furnace of any dimensions we deem necessary without the least apprehension of evil results. We do not for a moment contemplate the adoption of a locomotive or torpedo-boat boiler in the ordinary sense of the word at sea. But we might have a boiler containing at one end a locomotive fire-box, which box would communicate with the ordinary uptake of a marine boiler by three or more steel tubes, say each 12 in. in diameter, and 3 ft. or 4 ft. long. The shell of the boiler proper could be subdivided, so that nothing more than about 4 ft. in diameter would be exposed to a bursting pressure. Boilers in some respects resembling this type have been used at sea with success in the United States, but not with high pressures. It will be understood that what we propose is a boiler which shall combine the best features of the present marine type with the best features of the locomotive type. It would be, in short, a composite structure, and we see no reason to doubt that it might with due care be made a perfect success. There is just one other way in which high pressures may be carried at sea, namely, by using a number of small boilers—simply reduced copies of the large boiler—but, as we have shown, they must have small furnaces and small grates, and they would in the aggregate take up much more space than one or two large boilers of equal gross power.

Against everything that can be suggested, objections will be urged. But that quadruple-expansion engines and pressures of 250 lbs., or perhaps a little more, will be adopted within the next few years we feel certain, always provided that the right kind of boiler is to be had. It may be that the difficulty will be solved by departing much further than we have suggested from existing types.

Some Remarkable Breaks in a Reservoir.

[Abstract of a paper read before the Engineers' Club of Philadelphia by Mr. Lewis N. Lukens.]

THE reservoir was built in 1873 on the top of Conshohoken Hill, about 200 ft. above the level of the Schuylkill River, from which the water is pumped. In plan it is a square of 151 ft. at the top of the embankment, with a division embankment rising half way to the top of the side walls. When ordinarily full it holds about 1,000,000 gallons.

The earth of the locality is of a rather light character, with enough talc in it to make it feel rather greasy. The general rocks of the locality are limestone, and the variety quarried and sold as Conshohocken stone. The exact geological conditions of the locality I have not knowledge enough to describe.

In constructing the reservoir the banks were raised about as much above the natural level as the excavation was beneath it, the earth from the excavation being used for the embankments. These were well rolled and allowed to settle as much as possible in the course of construction. The bottom and sides were then lined with 18 in. of stiff fire-clay, put on in layers of about 3 in., each layer being well rammed. Above this there was put a brick pavement, and this was washed over with hydraulic cement.

The inlet and outlet pipes were cast-iron pipes laid in masonry. This masonry was composed of ordinary undressed stone, laid in hydraulic cement and extended out to about the middle of the embankment.

The reservoir was finished in the fall of 1873, and water was let in soon after. In December, 1873, only a few months after the water was let in, the first break occurred. This break commenced just above the outlet pipe and ollowed the line of the pipe through the embankment, faying bare some of the masonry described as surroundlng the pipe. It broke through the embankment just iabout at the natural level of the ground, and was about 15 ft. across at the top of the embankment, narrowing, of course, toward the bottom. The curious part was, however, that instead of the ground below showing evidences of such a large body of water passing over it, it showed that only a comparatively small part of the water had escaped that way and covered the low land just below. The larger part of the water must have escaped by some other channel, necessarily a subterranean one. This first break was repaired by filling in with stiff fire-clay and

finishing as before. In the summer of 1876 the second break occurred. This was in the middle of the west compartment and was an absolute giving way of the bottom, there being no break in the sides. It was simply a hole of about 25 ft. in diameter and of indefinite depth. A line was let down at least 85 ft. without finding bottom, and stones thrown in seemed to rattle down indefinitely. The ledges of rock seemed to be inclined toward each other thus, V, and the slippery talcous earth had been washed from between them, nobody knows where. Whether the water from the first break started it, is of course not known, although it seems, at least, possible.

In repairing this, the crevices between the rocks were filled up and arched over with masonry, going as deep as necessary to get a solid support for the masonry, in one case as much as 34 ft. below the bottom of the basin. The hole was then filled in with stiff clay and iron ore screenings, principally clay. The top was then planked over with hemlock planks, and the clay lining rammed down and covered with brick, as before.

In the spring of 1879, three years after, the third break occurred. This was in the other compartment, taking away part of the partition wall and part of the bottom, and was a good deal like the preceding one. An interesting fact is that a well near by, 80 ft. deep, and which had had 8 or 10 ft. of water in it, was completely emptied the night the break occurred and has not held any water since. There must have been some underground channel by which the water from both found its way to the river.

This hole was filled up with masonry and clay, like the other. The clay lining was then taken off, and the whole basin, sides, bottom and partition embankment, were planked over with heavy hemlock plank. The clay was then put on again to a depth of 14 in., and the whole surface bricked as before. This time it lasted for eight years, until last fall, when a small break occurred. Some small quantity of water had washed the earth from between two rocks, in the side of and near the bottom of the end embankment, in the same old way. The weight of the superincumbent water had then sprung back the side planks, and the water had escaped by some underground channel. Being relieved of the weight, the planks had sprung back. The fact of the springing back and subsequent release is shown by there being a number of small fish caught and crushed in the cracks. This was repaired, as usual, by filling in with fire-clay, and at that particular place there is now 3 ft. of fire-clay rammed in between the rocks, then the planking, then 14 in. more clay, and then the brick lining. It is hoped now that it will last.

THE NEW NAVAL VESSELS.

THE Secretary of the Navy has approved the report of the board which examined the plans for the new warships, so far as to direct the acceptance of the plan submitted by the Barrow Shipbuilding Company, of England, for the armored battle-ship. The Navy Department purchases the design, and is at liberty to make such modifications as may be desired. As it will take some two years to make the armor-plates for this ship and the armored cruiser, some time will elapse before work on the ships themselves is begun. The vessel, which will probably be built at the Brooklyn Navy Yard, is described below:

THE ARMORED BATTLE-SHIP.

The accepted plan of the Barrow Company presents the feature of having the water line well protected by heavy armor and also the guns on the upper deck, but of leaving the intermediate space between the upper and lower decks wholly without protection, there being nothing there of importance. The buoyancy of the ship is well assured by a deflective deck at the top of the waterline armor. Some of the recently built Italian battleships embody this principle, which has given rise to much discussion in professional circles. There are two turrets *en echelon*—that is to say, not in the middle of the ship, but on either side of the median line, so that their guns can fire directly forward and aft or to either side.

The designer was Mr. William John, an eminent naval constructor. His object was to present a design by which good steaming and manœuvring qualities could be obtained, an abundance of coal stowed, endurance, and the comfort of officers and men. A wider range of guns, with a heavy bow and stern fire is provided. Defense against attack by torpedo boats and boarders, the distribution of the machine guns and their protection; to accomplish this is one of the salient features. Another commendable feature is the ample protection afforded all vital parts of the ship from the enemy's shot and shell, by which the stability of the vessel is insured, even though the ends of the vessel were perforated above the protected deck; and if the ends of the vessel were perforated beyond the armor belt there would still remain some protective stability.

Following are the dimensions and general description of the armored battle-ship:

	Ft.	*In.*
Length between perpendiculars	290	0
Beam, extreme	64	1
Depth molded to upper deck	39	8
Mean draught of water	22	6
Displacement at 22 feet 5 inches draught, fully equipped, with 500 tons of coal on board (tons)	6,300	
Indicated horse power, forced draught	8,600	
Indicated horse power, natural draught	5,800	
Speed at above displacement, using forced draught (knots)	17	
Using natural draught (knots)	15½	
Battery—Two 12-in. breech-loading rifles; six 6-in. breech-loading rifles.		

The secondary battery consists of 22 machine guns, so disposed as to secure a heavy bow and stern fire and a good defense against torpedo-boat attack.

The vessel will be a twin-screw double-turret ship, with an armored redoubt enclosing the lower part of the turrets, the hydraulic machinery for moving the turrets and loading the guns and the funnel casings of the boilers.

It is fitted with a ram bow, heavily strengthened, forming a powerful weapon. The hull is built entirely of steel on the cellular system, the double bottom extending throughout the machinery and magazine spaces—a length of 158 ft.

This bottom is divided into numerous water-tight compartments, as is the hull, by numerous longitudinal and athwarthship bulkheads. The protection of the vital parts of the ship consists of a steel-faced armor belt 12 in. in thickness, extending sufficiently forward and aft to embrace the engines, boilers and all magazines, terminating at each end with an armored steel-faced breastwork 6 in. thick extending diagonally across to the center of the vessel.

This armor is thoroughly backed by a system of rigid framing and girders; additional protection is furnished by a steel deck 3 in. thick, extending the whole length of the vessel, sloping from beyond the armor belt toward the bow and stern, protecting the steering gear and underwater torpedo rooms and gear.

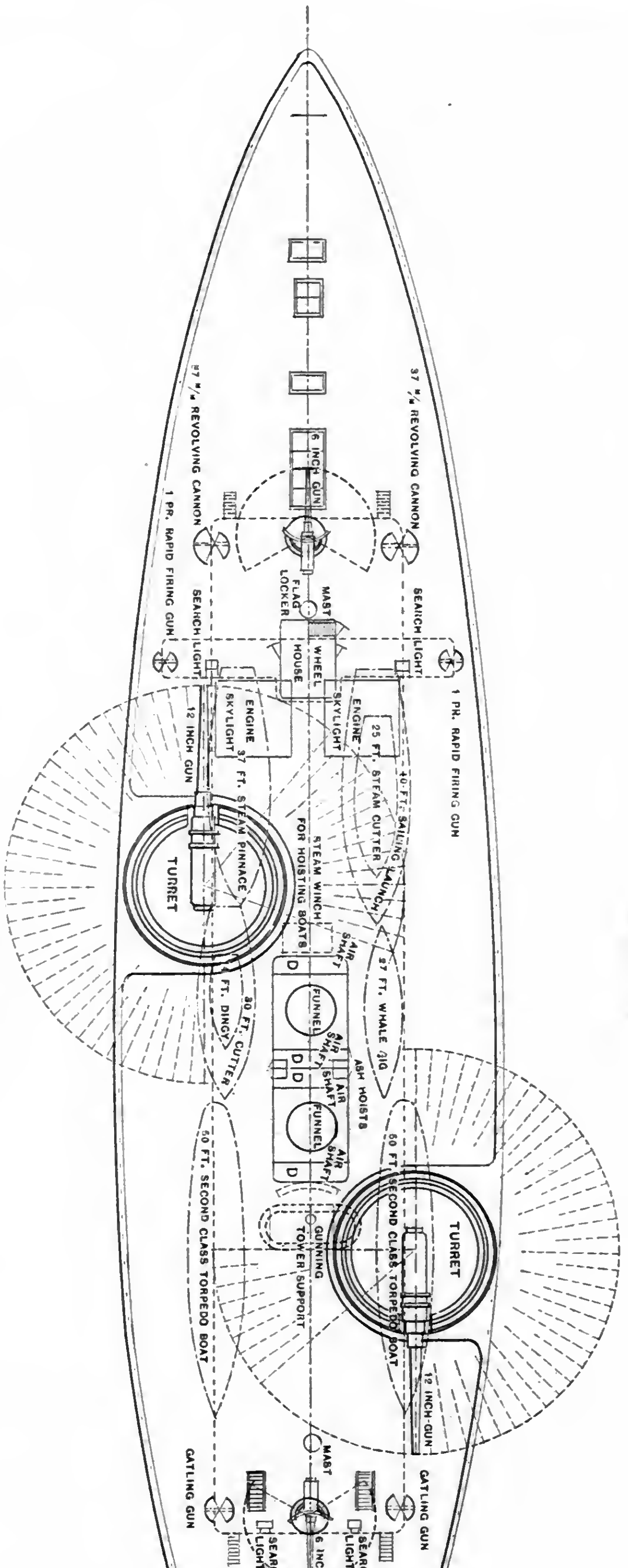
Above the protective hull are the main and spar decks, where the accommodations for the officers and crew are arranged and batteries located.

The machinery is all placed below the protective deck, the engines in two and the boilers in four water-tight compartments.

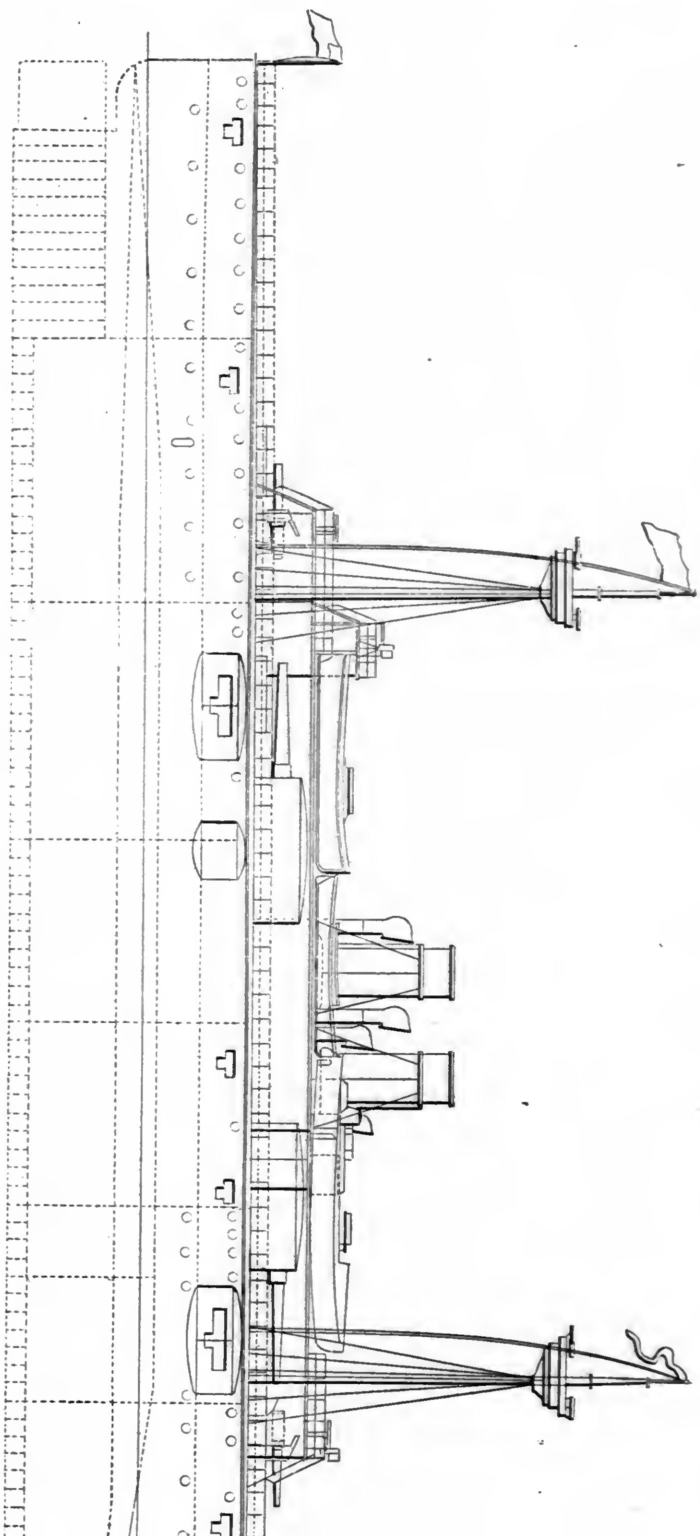
The stowage of coal is so arranged as to afford as much protection to the unarmored parts of the vessel as possible.

The two 12-in. breech-loading guns are mounted each in a turret protected by 12-in. steel-faced armor. These turrets are placed *en echelon*, so as to command a fore-and-aft fire from both. Each gun has a complete broadside range on one side, and a range on the opposite side of 40 degrees for the forward gun and 70 degrees for the after one. Two loading positions are provided for each gun. Two 6-in. guns are arranged as bow and stern chasers, to be placed on central pivot mountings supporting segmental shields. These are mounted on the spar deck—one forward and one aft—with a range of 120 degrees.

Four 6-in. guns are arranged in sponsons on the main deck, two commanding a range from right aft to 25 de-



UPPER DECK PLAN.



ELEVATION.

DESIGN FOR ARMORED BATTLE-SHIP, U. S. NAVY.

grees forward of the beam, and two a range from right forward to 25 degrees abaft the beam. Six tubes are also provided for ejecting torpedoes.

Two military masts are fitted to carry machine guns.

THE ARMORED CRUISER.

The Board did not recommend the adoption of any of the designs submitted for the armored cruiser, and before making any decision, a careful examination of these plans is to be made. It is thought probable that the design prepared by the Bureau of Construction of the Navy Department may be adopted. This plan, as has been heretofore noted, has many points of resemblance to the celebrated Brazilian turret-ship *Riachuelo*, although many improvements in the original model have been introduced. The general dimensions are as follows: Length, 310 ft.; breadth, 54 ft.; draught, 21 ft. 6 in.; displacement, 6,600 tons; speed, 17 knots; coal capacity, 800 tons. Four 10-in. guns are carried in turrets *en echelon*, and six 6-in. guns are mounted in central pivot carriages, so arranged that all of the 10-in. and three of the 6-in. guns can be concentrated on one point of fire, while 13 rapid-fire guns have practically an all-around range. The armor belt is 17 in. in thickness and 6 ft. in breadth. The vessel will be fitted with torpedo tubes for the discharge of fish torpedoes, carries two steam torpedo boats, and is rigged as a bark.

Hydro-Pneumatic Disappearing Gun-Carriage.

THE accompanying engravings show a disappearing gun-carriage, on the hydro-pneumatic system, made at the works of Sir W. G. Armstrong, Mitchell & Co., and shown at the Exhibition at Newcastle, England.

In the system illustrated, the recoil set up on firing the gun is utilized for compressing air in a chamber of the recoil-cylinder, by means of water or other fluid which is forced from the outer chamber through a valve into the air chamber. At the same time the movement of the ram in the cylinder is communicated, by means of a crosshead, to a pair of elevating levers, in the upper ends of which the gun trunnions are carried, the lower ends being connected to the gun-carriage. On being fired, the traverse of the ram causes the elevating levers to descend, carrying the gun with them, and, as above stated, compressing the air in the recoil-chamber at the same time. When the gun has been loaded in its lowest position this energy is utilized for raising it, as shown in the lower view of our illustration, into the firing position.

The engravings given show the construction of the apparatus very clearly. It has excited much interest in the Exhibition.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Continued from page 309.*)

WE continue below the condensed summary of the reports of the Board of Trade inspectors on accidents resulting from breakages of wheels and tires on British railroads. This summary was begun in the June number of the JOURNAL, and its purpose and object were there explained.

In the last number these condensed reports were brought down to the close of 1872, and the record is now taken up from the beginning of the year 1873.

ACCIDENT REPORTS.

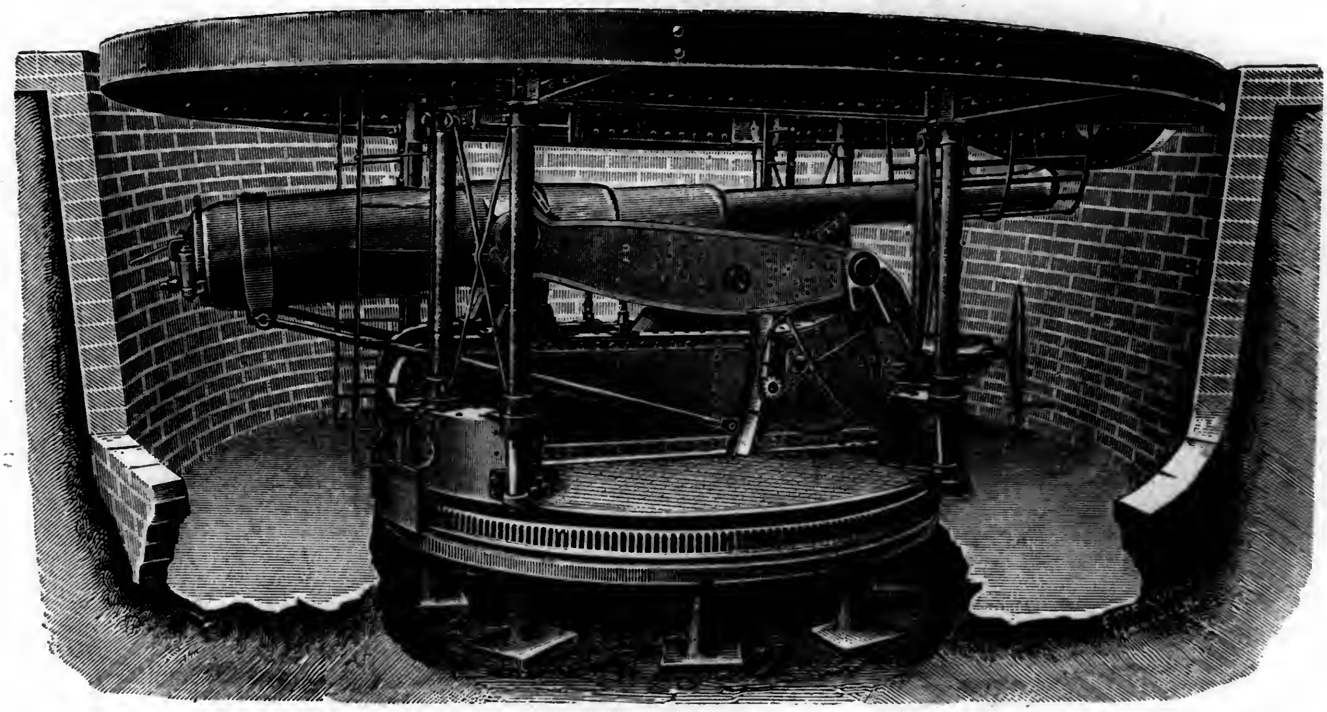
January 6, 1873, as an express train on the Midland line was near Royston, a tire broke on a leading wheel of the engine and flew off, throwing the engine from the track. A passenger was hurt. The tire broke into 6 pieces, which were, respectively, 65, 13, 26, 22, 4½ and 24½ in. long; they were scattered along for some 600 ft. beside the track. Some 200 ties and 25 rails were broken by the train. The tire was of crucible steel and had run 50,438 miles, wearing down from 2½ to 2⅜ in. It was secured to the wheel-center by 6 set-screws, each ⅞ in. in diameter and penetrating 1⅛ in. into the tire. Three of the breaks were through bolt-holes. In this case the Inspector comments very severely on the insufficient method of fastening the tires used.

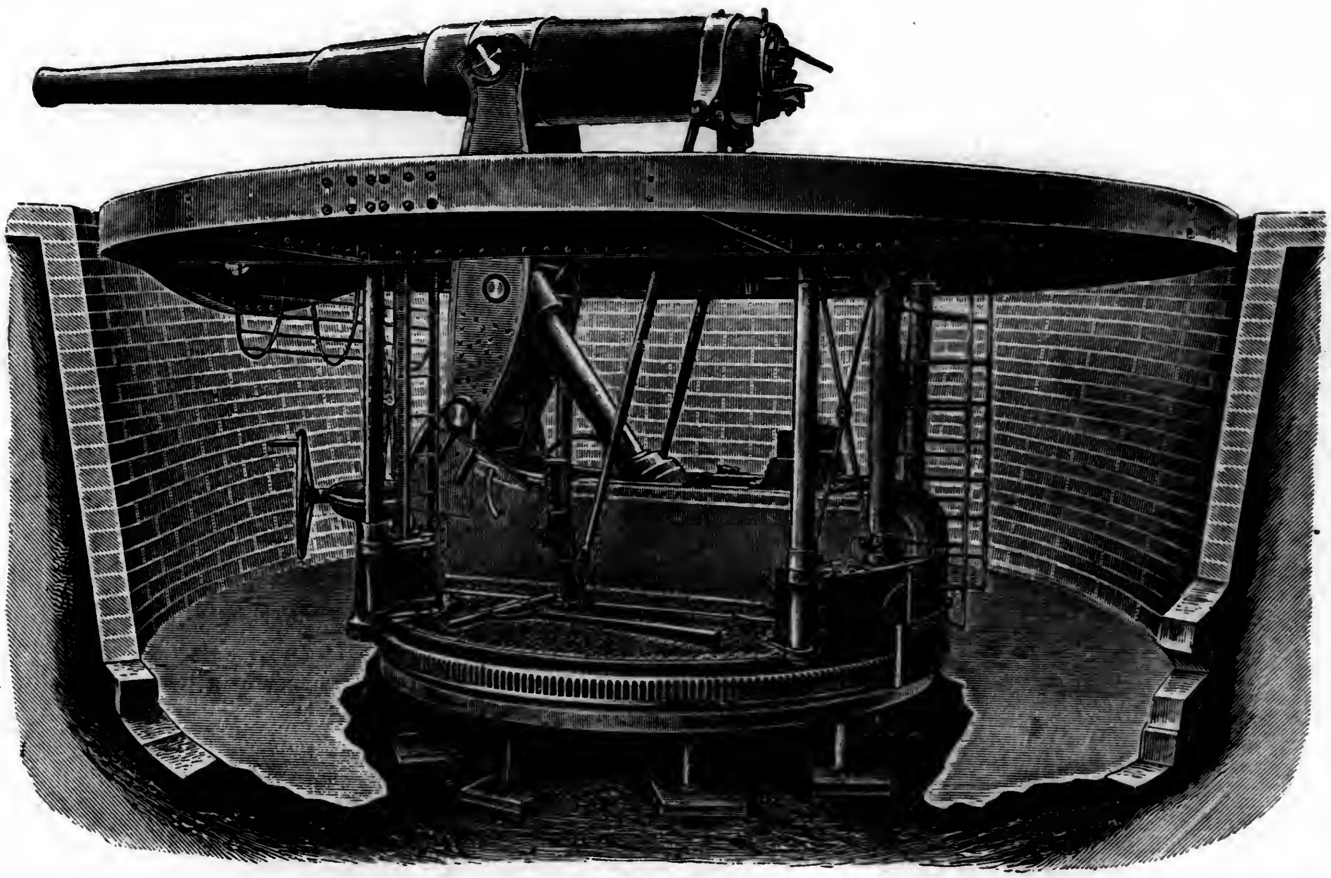
January 8, 1873, a tire broke under a passenger carriage of an express train on the Midland Railway, near Dore. The carriage did not leave the track, but one passenger was hurt by a piece of the tire which was thrown up through the floor This tire was of iron, originally 2-in. thick on tread, but worn down to 1¾ in.; it was fastened to the wheel-center by four rivets. It broke into 6 pieces, 44, 33, 8½, 13½, 22 and 12 in. long respectively, four of the fractures being through bolt-holes. The Inspector again urges the use of such fastenings as will hold the tire in place even if broken.

April 28, 1873, a tire broke on a driving wheel of the engine of a passenger train on the Midland Road, near Stenson Junction. The wheel was 6 ft. 6 in. diameter; the tire had been last turned up in January, 1873, the engine having been in service since 1852. The tire was originally 2½ in. thick on tread, but had been reduced to 1⅜ in. by wear and turning. It was fastened to the wheel-center by 7 bolts, ⅞ in. diameter. It broke into 6 pieces, and no flaws were found in the metal. The inspector thinks that this breakage was the result of trusting too long to a worn-out tire, and again urges the use of better fastenings.

May 1, 1873, a passenger train on the Great Western was derailed near Upton Magna, by a broken tire under a brake-van, all the train except the engine leaving the rails; a guard and 11 passengers were hurt. The tire broke into 11 pieces, which were scattered for 400 ft. along the line. The tire was iron and seems to have broken first at the weld, where a slight flaw was found. Another crack or flaw was found at a second break, but neither of these flaws was large enough to seriously impair the strength. The fastening to the wheel-center was by the Gibson method, in which a circular key-ring is used, fitting into a groove in the tire. It seems that this groove was defective at one point, and a piece had been cut out of the key-ring. This ring disappeared when the tire broke, and had not been found when the report was made. The tire was of iron, and tests made on the pieces showed that the metal was somewhat brittle. The Inspector says: "The Great Western Company has about 100,000 wheels on which the tires are fastened in the same manner; and I am informed by Mr. Armstrong, the Locomotive Superintendent, that he has only known one instance in which a tire after breaking has left a 42-in. wheel. * * * * As it is impossible to prevent tires from breaking occasionally, in consequence of hidden flaws or some imperfection in the metal, it is of paramount importance to prevent them from leaving the wheel-center when breakage does occur."

June 21, 1873, an excursion train on the Midland Railway was derailed near Wingfield by the breaking of a tire on a leading wheel of the engine. The engine, brake-van, and 4 carriages were derailed, killing 2 passengers, seriously injuring 3 trainmen and 12 passengers. The engine in this case was a six-wheels coupled engine, with 16½ by 24 in. cylinders, and wheels 62½ in. diameter; it weighed 33½ tons, about 11 tons being on the leading wheels. The tire which broke was of crucible steel; it had run 117,154 miles and had been reduced from wear and turning from 2½ to 1¾ in. thick on thread. It was secured to the wheel-center by 8 screw-bolts or set-screws, each 1 in. in diameter, and tapped about 1 in. into the tread of the tire. The tire was found to be in five pieces, 72½, 46¼, 32½, 26½ and 12 in. long, respectively. This case seemed of so much importance that, in the course of the investigation, letters were sent to all the railroads in the country, asking them to give statements





HYDRO-PNEUMATIC DISAPPEARING GUN-CARRIAGE.

MADE BY SIR W. G. ARMSTRONG, MITCHELL & CO., ELSWICK, ENGLAND.

as to the method of fastening tires in use on their respective lines.

In summing up this case, the Inspector says: "It is probably impossible, in the manufacture of tires and in applying them to the wheels of locomotives and railway vehicles, to provide against their occasional failure in this manner; but it is possible, as I have frequently and for many years had occasion to point out, almost absolutely to prevent danger to passengers and trainmen in the event of their failing, by attaching them to the rims of the wheel-centers by methods which will prevent them flying off the wheel when broken. They may fail from too brittle nature of the material, from defects of manufacture, or from being too tightly shrunk on to the wheel; and they have frequently failed from one of these causes, or from a combination of them. The danger is not in the fracture, or in the tire being divided into two or more parts, but in the probability of the tire, which is or ought to be, in a state of tension on the wheel, flying suddenly and violently from it when fracture occurs; and this danger is greater with steel than with iron tires. The loss of a tire from a wheel in any part of a train traveling at a high speed, must always be an occasion of serious risk, but it is especially so with regard to the tires on the leading wheels of the engine. The risk being so great and the remedy so simple, involving no extra cost worth a moment's consideration, it does appear surprising that there should have been so much difficulty in inducing railroad companies to adopt this remedy. Having procured the best tires they can manufacture or buy, they too often proceed to bore great holes in them and so to weaken them seriously, in order to fasten them to the rim of the wheel, when there are superior methods of attaching them to the wheels without making such holes in them, and by means of which they may wear them down safely, without fear of accident in the event of their fracture, and with less risk of fracture occurring. * * * *

"As regards the different modes of fastening tires, there is, no doubt, much to be said, and there is much diversity of opinion. But the various companies will do well to study the results of experience up to the present time. There have been instances of broken tires flying from the wheels, when secured by clips on one side only, and by wedges, or rings, or bolts only, on the other side or in the middle. There have also been cases of the failure of wooden wheels. But there has not yet been a case, so far as I am aware, of a tire flying from a wheel when the double-clip system has been adopted, and this system may be and has been adopted with iron, as well as with wooden wheels. The principles which appear to promise the greatest degree of safety may thus be stated:

"1. There should be a clip of some sort on each side of the tire, and not on one side only.

"2. The clips should be formed with square shoulders, as I pointed out in a report on tire-fastenings nearly 13 years ago, and not with a slanting dovetail.

"3. The clips should be continuous on both sides, and not intermittent (with spaces between the portions) on one side, as they are in some cases.

"4. The strength of the clips, and of the portion of the tires clipped, should be in proportion to the strains which are liable to be brought to bear upon them, having regard to the material and strength of the tires."

December 12, 1873, a tire broke on the leading wheel of the locomotive of a passenger train, on the Midland road near Spondon; the train was not derailed. The tire, which was of crucible steel, broke into seven pieces, two of the breaks being through bolt-holes. It was originally 2½ in. thick on the tread, but had been turned and worn down to 1⅞ in. It was fastened to the wheel-center by six screw-bolts passing through the rim and entering 1¼ in. into the tire. The Inspector speaks strongly of the defective fastenings of the tire.

December 13, 1873, on the Northeastern Railway, near Guisboro Junction, a tire came off a wheel under the tender. The tire was of Low Moor iron, 42 in. diameter, and was secured to the wheel-center by three rivets. The tire did not break, but it was found that all of the rivets were broken, one showing a fresh break, the other two having apparently been broken for some time. The Inspector believes that the breakage of the rivets was due to expansion of the tire by heat, resulting from friction of the brake-blocks.

December 28, 1873, the brake-van of a passenger train on the the Great Northern road was derailed near Wood Walton, by a broken tire and pitched 30 ft. down a bank. About two-thirds of the tire left the wheel in 6 pieces, the remaining third being held to the wheel by the fastenings; these consisted of 8 L-shaped clips, fitting into a groove in the tire, and secured to the rim of the wheel-center by screw-bolts, one in each clip. The tire was of steel, five years old, and was 1¾ in. thick on the tread.

May 8, 1874, a tire broke under a carriage in a passenger train on the Dublin, Wicklow & Wexford line, derailing the whole train. The tire broke at a weld, and the wheel-center, which in this case was cast-iron, was broken to pieces.

July 17, 1874, mixed train on Northeastern line was derailed near Chat Hill, by a broken tire under a freight wagon. A trainmen and 3 passengers were hurt. The tire, which was of very poor iron, broke into four pieces, the breaks being at the bolt-holes where it was fastened to the center. The fastenings were insufficient to hold the tire.

December 24, 1874, a passenger train on the Great Western was derailed near Shipton-on-Cherwell, by the breaking of a tire. This was one of the worst accidents on the record, several carriages having been completely wrecked, 30 passengers killed and 4 fatally hurt, 65 other passengers and 4 trainmen injured. The tire which broke was of Low Moor iron, and had been in service 9 years; it had been worn and turned down from 2½ to 1⅞ in. thick on tread. It was fastened to the wheel-center by four countersunk rivets, with a small lip on the inside of the tire to resist the pressure of the flange. The rivets were ¾ in. diameter, enlarged at the counter-sinking to 1¼ in. at the top of the rivet, and the length of the tapering part was 1½ in. when new. The head was riveted up hot in the usual way. The tire broke in two pieces, about 3 and 8 ft. long, and three out of the four rivets broke. In this case there was an extended investigation, on account of the loss of life, but the comments made are chiefly a repetition of the statements found above, in relation to the necessity of using proper fastenings for tires, and of employing some means of preventing them from leaving the wheel-center when broken.

January 2, 1875, passenger train on North British Railway was thrown from the track near Buchlyore, by a broken tire under a passenger carriage, and 10 passengers were hurt. The broken tire was 52 in. diameter of iron, and was about 1½ in. thick on thread, although somewhat unevenly worn; it was secured to the wheel-center by five ⅞-in. rivets. It broke into four pieces, all the breaks being through rivet-holes.

August 21, 1875, a passenger train on the Waterford & Limerick line, was derailed near Long Pavement, Ireland, by a broken tire on a leading wheel of the engine. The fireman was killed, the engineer and a passenger hurt. The broken tire was of steel 4 ft. diameter and 2 in. thick on tread; it was fastened to the wheel-center by five ⅞ in. bolts, with countersunk heads 1⅛ in. diameter in the tire. The tire broke into three pieces, two of the breaks being through bolt-holes. The rim of the wheel-center broke in two places.

August 24, 1875, two carriages of a passenger train on the Midland Railway were thrown from the track near Kilnhurst by a broken tire. This tire broke in two pieces and left the wheel altogether. It was of steel, almost new (in use 38 days only), and broke, apparently, first at a bolt-hole, and then at a point where a flaw seemed to have occurred in rolling it. The Inspector says that the steel seemed brittle and should have been better annealed. It was held to the wheel-center by four ⅞ in. bolts, with countersunk heads, tapering from 1⅛ to ⅞ in. The Inspector censures the company very severely for continuing to use fastenings which had proved unsafe and insufficient years before, when so many better systems were in use on other lines.

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For the year 1874, the total number of accidents given by the companies' reports, made under the law, from

broken tires, was 55, and from broken wheels 13; a total of 68 accidents. In these accidents, 34 passengers were killed, 66 passengers and 7 employes were injured. Nearly all these casualties were, however, due to a single accident, most of the accidents having been slight in their results.

It will be observed that, in only three out of these 68 accidents, was it considered necessary to hold a special examination, and only three of them are mentioned above.

From 1847 to 1874, inclusive, the Inspectors examined into and reported on 81 accidents, resulting from breakage of tires. The total number killed in these 81 accidents was 65 passengers and 8 employés; injured, 268 passengers and 38 employés.

As in the earlier reports, there were exceedingly few breakages of wheel-centers included in these reports, and in almost every case these breakages resulted from failure of tires. In nearly every case where the tires broke, the damage done would have been slight had the tire been sufficiently fastened. Safe fastenings seem to be the burden of the Inspectors' reports throughout.

(To be continued.)

Tramway-Trains

AT a recent meeting of the (French) *Société des Ingenieurs Civils* the subject of Tramway-Trains was brought forward by M. Cossmann. This appellation has been chosen to designate light conveyances which, like tramcars, stop frequently, but have a velocity equal to that of the ordinary trains. It is nearly 10 years since they were first tried in Austria, and in the environs of Berlin; from thence the idea spread into France and was adopted with certain modifications in accordance with the different requirements and the restrictions of the Legislature. To authorise a departure from existing regulations a presidential decree was found necessary, which was granted on the application of the Administration of the State Railways. The three articles of this decree related to the length of the train, the number of men accompanying each train, and the precautionary measures to be observed *en route* and at the stations; the rate of speed also to be determined by ministerial orders.

The question appears to have fallen into abeyance for about two years. At the end of that time, in 1884, the Compagnie du Nord, alarmed at the falling off of their traffic, took measures to reduce the working expenses of each line in proportion to the receipts, and resolved to try the system of tramway-trains on a branch of their Belgian line, and on two of their French lines. The system had already been applied in a suburb of Liege, on a line running between that town and Maëstricht. Of the two French lines, that between Lille and Tourcoing was considered suitable for the trial of a single carriage tramway-train, and on the line running from Boulogne to St. Omer, it was thought that light trains composed of several carriages would be better fitted to the requirements of the traffic. The results of this decided the company to develop and extend the application to several sections.

Other French companies are beginning to follow the example of the Compagnie du Nord. To the east, there are two lines in the Department of Meurthe-et-Moselle; to the west, it is proposed to extend the system to the Bretagne lines, and to some branches of the Seine Valley.

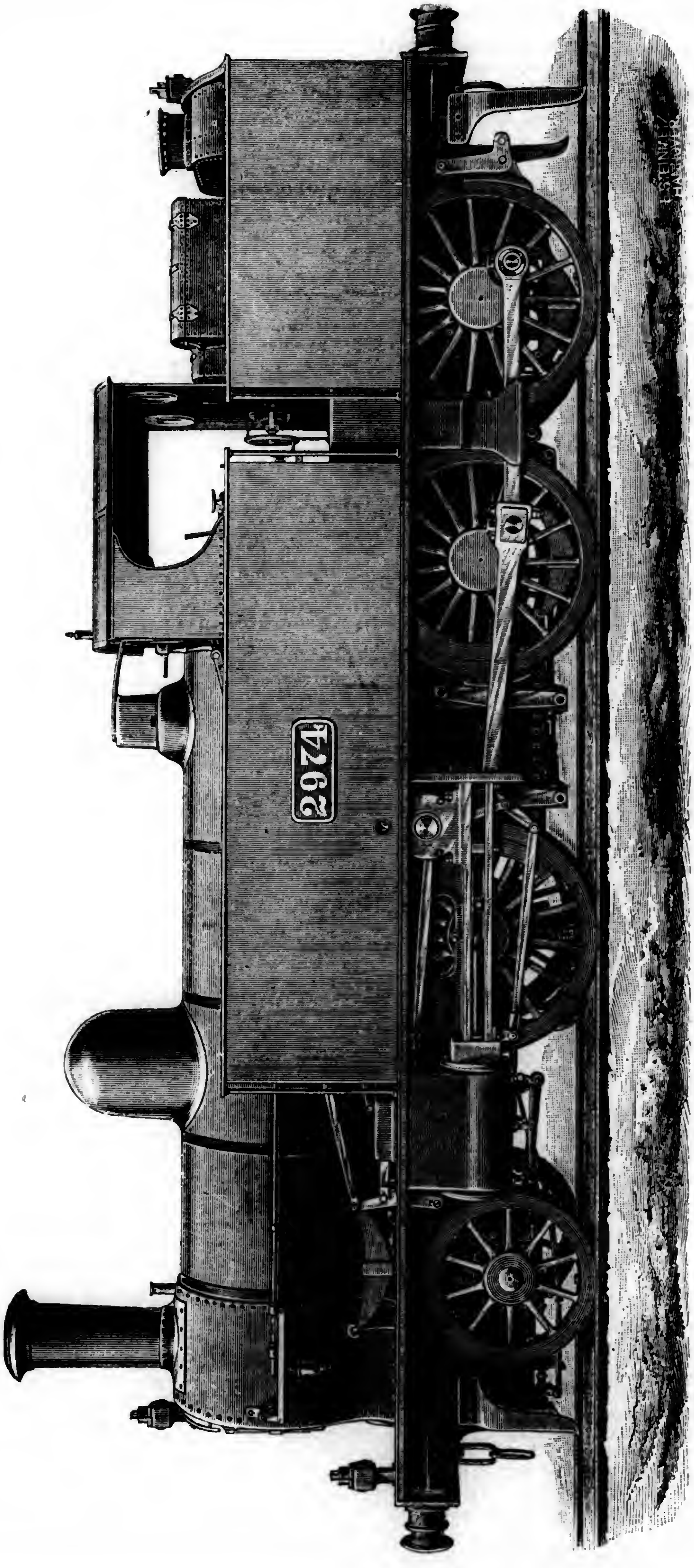
Since the 21st of September tramway-trains have been running from Villeneuve-St. Georges to Palaiseau, and an extension is contemplated between Plaine and Pantin.

The characteristics of the tramway-trains employed over the Northern line are as follows:—(1) They are composed of an engine and one large carriage, or of a limited number of carriages, and have no brake van. For such light trains an engine of moderate power is sufficient to keep up a relatively high rate of speed, and this is maintained in spite of the numerous stoppages, the number of which is regulated by the public requirements. A driver and one guard only are required, where the trains have but one carriage; where they have more than one but less than seven, two men on the engine and one conductor are requisite; (2) the stoppages take place at points between the stations, where there are neither signal boxes nor ticket offices, the tickets being distributed in the train itself by the guard as in the ordinary tramways. In establishing tramway-trains in connection with their railways, the Compagnie du Nord has had to make two distinct provisions for their service; (1) In the neighborhood of the great centers, such as Paris, Lille, Maubeuge, the tramway-trains composed of one carriage are worked in correspondence with the existing trains by the addition of another track and are confined to passenger traffic only; (2) on the branch lines, where the goods and passenger traffic are distinct, the ordinary trains are substituted by light trains, composed of from one to six carriages at most, without a brake-van; they carry the mails, parcels and passenger luggage, and, like the one-carriage trains, stop at intermediate points. Being light and provided with the continuous brake, they are able to stop and start very rapidly. These trains, where the service requires it, can be converted into ordinary trains by the addition of carriages, a brake-van and the ordinary number of attendants. The company has avoided the construction of new material, and has, in most cases, adapted the old to the requirements of the new service.

The engines employed are old locomotives, the tenders of which are suppressed, and provision made at the side for the accommodation of fuel and water, in order to leave the passage between the engine and the platform of the carriage perfectly free. These engines are about 15 tons in weight, and have a tractive power of three tons. The carriages are composed of two old carriages united, having a passage down the center and platforms at the extremities. They are 11 meters long, and contain 75 places in three classes, with a compartment for the guard. The carriages used in the vicinity of Paris are composed of three thrown into one, and have 102 seats. The light trains have the common form of carriages, that they may be converted into ordinary trains as the case demands.

The arrangements made at the stations are as rudimentary as possible; two platforms of earth are formed, contiguous to a crossing, and put under the superintendence of an attendant. The number of stoppages is now 47, and they are being increased every day, in answer to the demands of residents, who are willing themselves to bear the slight expense incurred in installing them. The rate of speed is about the same as that of the ordinary trains; although there are double or treble the number of stoppages, they are of short duration, so that but little time is lost.

Taking the results obtained on the Lille and Tourcoing line, the working expenses of the tramway-trains of one carriage amount to 13 cents per mile, and those of the light trains of six carriages to a maximum of 19 cents, while a mixed train costs at least 22½ cents. It will be seen then that a real advantage is gained in substituting the ordinary trains by tramway or light trains. It is more difficult to justify the economy of inserting tramway-trains into the existing service, since there is, in the first place, a supplement of expenses to take into account, but the system is to be recommended where the traffic is likely to increase and require more trains. It should not be concluded that this system can be profitably applied everywhere; the question should be studied line by line to determine where it could be adopted with advantage or otherwise. The object in view in starting tramway-trains in Austria was to promote local traffic. To provide for at least three or four journeys per day, where the travelers would not exceed in number some eight or twelve persons per journey, it did not pay to run the ordinary heavy trains; the wear and tear of the rails and other expenses quickly swallowed up the receipts. It was decided, therefore, to set light engines and carriages upon the rails, to work at a reduced speed and to stop at close stages. In consequence of this reduction of speed they have been



COMPOUND TANK LOCOMOTIVE FOR FREIGHT SERVICE.

BUILT AT THE LONDON & NORTHWESTERN SHOPS, CREWE, ENGLAND; F. W. WEBB, CHIEF MECHANICAL ENGINEER.

able in Austria to reduce the tariff 33⅓ per cent. below the ordinary prices.

According to M. Kopp, the receipts in the suburbs of Vienna in 1880 amounted to about 38 cents per mile and the expenses to 17½ cents only. The speed is generally fixed at 18 or 19 miles per hour, and descends in some cases as low as 14 miles. The project has been worked out very successfully, and the example has been followed by Germany, France, Italy and Belgium. In the latter country, however, the general use of tramway trains is still under consideration; as yet they are only employed around Liege and on the Chirnay line.

Compound Tank Locomotive.

THE accompanying illustration is a perspective view of a compound locomotive, intended for freight traffic, and built at the Crewe Works of the London & Northwestern Railway, from the designs of Mr. F. W. Webb, Chief Mechanical Engineer. The engine has side-tanks and is carried on four pairs of wheels, of which three pairs are drivers, while the leading wheels are fitted with Mr. Webb's well-known radial axle-box. The system is very much the same as in the *Dreadnought* and other compound passenger engines of the same class built by Mr. Webb. The high and low pressure cylinders work on different axles, which are not coupled or connected.

In the present engines, as will be seen from the engraving, the two hind pairs of wheels are coupled, and are driven by the pair of high-pressure cylinders, these cylinders being 14 in. in diameter and 24 in. stroke. As in the case of Mr. Webb's other compounds, the valve gear is of the Joy pattern, but, owing to the small size of the wheels, the valve chests of the high-pressure cylinders have to be placed above the cylinders, instead of below, as in the compounds for fast passenger service.

The axle of the front pair of driving wheels has a single central crank, to which the piston of the low-pressure cylinder is coupled, this cylinder being 30 in. in diameter, with 24 in. stroke. The cylinders of this engine, now illustrated, are of the same sizes as those of Mr. Webb's *Dreadnought* class of passenger engines, about which so much has been written.

The driving wheels of the engine under notice are 5 ft. 2½ in., and the leading wheels 3 ft. 9 in. in diameter. The total wheel base is 21 ft. 6 in., of which 14 ft. is the wheel base of the three pairs of driving wheels. The boiler is worked at a pressure of 160 lbs. per square inch and has 1,099 square feet of heating surface, of which 95 square feet is firebox surface, and 1,004 square feet tube surface. The grate area is 17.1 square feet, and the weight of the engine, empty, is 43½ tons. The tanks carry 1,400 gallons of water.

Engines of this class are, it is stated, doing very good service on the London & Northwestern road. Mr. Webb promises to publish hereafter some particulars of their work.

A Problem in Profit-Sharing.

[Abstract of Paper read before the American Society of Mechanical Engineers at the Washington meeting by Mr. William Kent, of New York.]

IF we admit that sharing of profits among the workmen will benefit both employers and employed, on what basis should profits be divided in a business in which they depend rather upon the selling than upon the manufacturing department?

Suppose three manufacturing companies—A, B and C—each produces per year 100,000 of an article which, under average conditions, costs $1 for labor, material and shop-expenses. It is sold by advertising, by agents and by discounts at a cost of, say, $100,000 per year. The average selling price is $2.10. All three concerns being on the same footing, each makes 10 cents profit on one article, or a total of $10,000 a year.

Suppose that the next year, the average selling price is reduced to $1.50. A then, to cheapen production, introduces the profit-sharing system, and, in expectation of sharing profits, the workmen become so much more efficient that the cost of production, for labor, material and shop-expenses, is reduced to 75 cents, the stipulated daily wages being reduced 5 per cent., and the production increased 25 per cent. The selling organization and expenses remain the same as in the preceding year, being $100,000, or 80 cents on each of the 125,000 articles. The total cost for production and sale is, therefore, $1.55, or 5 cents more than the selling price, making a loss of $6,250, and no profits to be divided among the workmen, although their wages were reduced 5 per cent. in expectation of such profits.

B puts in better machinery, runs overtime, pays the same wages as before, doubles its product and reduces the cost of production to 80 cents. More liberal advertising and more agents increase the selling expense to $120,000, which, divided by 200,000 articles sold, is 60 cents each. The profit and loss account then shows:

200,000 manufacturing cost at 80c.	$160,000
do. selling expense cost at 60c.	120,000
Total cost	$280,000
do. sold at $1.50	300,000
Profit	$20,000

C thinks its selling department costs too much, cuts down salaries, commissions and advertising, so that the yearly expense of selling is reduced to $40,000; does not increase the quantity of business as A and B did, but sells 100,000. No change being made in manufacturing, the article costs, as before, $1 each. Result:

100,000 manufacturing cost at $1	$100,000
do. selling expense at 40c.	40,000
Total cost	$140,000
do. sold at $1.50	150,000
Profit	$10,000

A has the most efficient workmen, who give up 5 per cent. of their wages, and reduce the cost of production 25 per cent., yet these, through no fault of their own, get no profits, and less wages than the workmen of B and C. B and C both pay their workmen as before, and both make a profit through the adoption of two opposite lines of policy, B spending money more liberally, C cutting down expenses.

Does not this show that, if profit-sharing be adopted where selling of the articles is entirely separate from making them, the share of the workmen should be calculated not on the profits of the whole business, but on the savings in the manufacturing department alone?

A's workmen were entitled to a share in the 25 per cent. which they saved in manufacturing; and if the selling department had been managed like those of B or C they would have obtained it. Had B and C adopted the profit-sharing system in addition to change of policy in selling, their profits would have been still greater, for their cost of production would have been reduced.

The following is suggested as a fair basis: From the statistics of a year's production make an estimate of the cost for labor and shop-expenses. Call this the maximum allowable cost for the next year. Pay the same daily wages as before, and, at the end of the year, in addition, a certain percentage, agreed on at the beginning of the year, of the difference between the maximum allowable cost and the actual cost, if there has been a saving. It might be fair to deduct from the maximum cost any saving clearly due to introduction of new machinery or expenditure of capital, and not to increased efficiency of workmen.

The following is an example under this method:

No. of pieces made.	Material.	Labor.	Shop Expenses.	Total.	Labor and s. ex. only
1st year, 100,000	$20,000	$60,000	$20,000	$100,000	$80,000
Each piece costs	20c.	60c.	20c.	1.00	80c.
2d year, 150,000	30,000	70,000	20,000	120,000	90,000
Each piece costs	20c.	46⅔c.	13⅓c.	80c.	60c.

Maximum allowable cost for labor and shop expenses 150,000 at 80c	$120,000
Actual cost 150,000 at 60c	90,000
Saving	$30,000

This saving of $30,000 is to be divided between the employers and employés in proportions previously agreed upon. The shop expenses, including rent, taxes, insurance, gas, fuel, wages of superintendents and clerks in manufacturing department and wear and tear of machinery, are properly included in the amount upon which savings should be calculated; since, if their total cost is a fixed sum per year, the cost per piece produced depends upon the number of pieces made, and hence, to a great extent, upon the efficiency of the workmen. The cost of the raw material is not included, because this depends upon fluctuations of market, and to some extent upon foresight and judgment of the purchasing department, and generally not upon the efficiency of the workmen. Material spoiled, or excessive waste of material, might be charged as part of cost of labor.

By this method the profits to be divided among the workmen are are those which they make themselves by more rapid work, carefulness in avoiding waste and by general increase of skill. It removes the most serious objection, that it is easy for the capitalist to share profits with his workmen, but impossible for the workmen to share in the losses, which the capitalist must bear himself. It makes the workmen share the losses if there are any in the manufacturing department, in which department alone the workman is concerned. He shares neither the profits nor the losses of the purchasing and the selling departments, with which he has nothing to do.

Steel Ties on the Netherlands State Railroad.

[Paper by M. G. Braet, Engineer of Maintenance of Way, Belgian State Railroads, in the *Bulletin* of the International Railroad Congress.]

THE company operating the Netherlands State Railroad put in service several months ago, on a line traveled by express trains between the stations of Tilbourg and Breda, a new rail-section carried on metallic ties of the modified Post type.

The modified Post tie has the form of an inverted

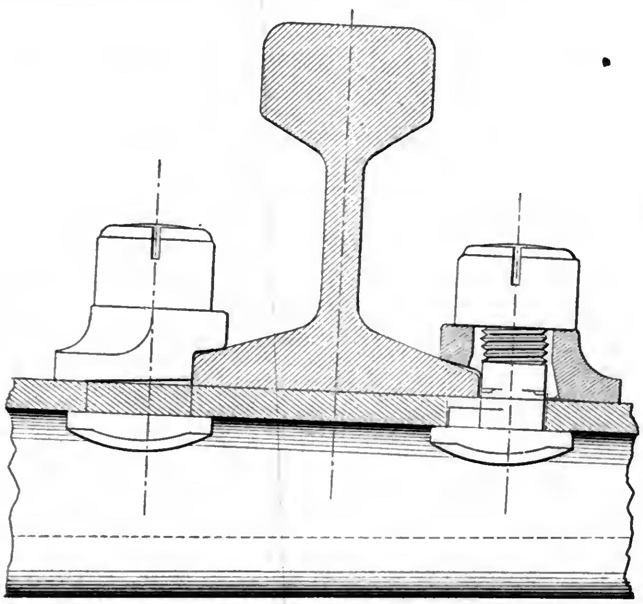


Fig. 1.

(*Inclination of rail, 1 in 20.*)

trough of a regular polygonal section (fig. 3) with rounded angles; its lateral faces, which are at an oblique angle, are provided below with a small rib or projection intended to facilitate penetration into the ballast. The upper surface of the table is curved at the ends and falls below the general surface of the tie in such a way as to take hold in the ballast, and, consequently, to oppose the tendency to displacement transversely to the rail.

The lower sides of the tie, which are horizontal for a distance of 85 centimeters (34½ in.) from the ends, are arched downwards toward the middle, in such a way as to induce the lateral faces of support to imbed themselves in the ballast and thus to oppose the tendency to movement in the direction of the length of the rail.

In the upper surface or plan of the tie, the top or table widens at the ends and is drawn in at the center. The widening at the end furnishes a greater supporting surface, and, consequently, contributes in some measure to the stability of the rail.

As to this narrowing in the middle of the tie, M. Post, the Engineer of the company, sees in it a special advantage for roads with poor ballast, and where the tamping is little cared for. In roads which are placed under such unfavorable conditions, the tie, if of uniform size, forces itself down into the ballast and often finds a point of rest in the center, causing an oscillation or rocking movement

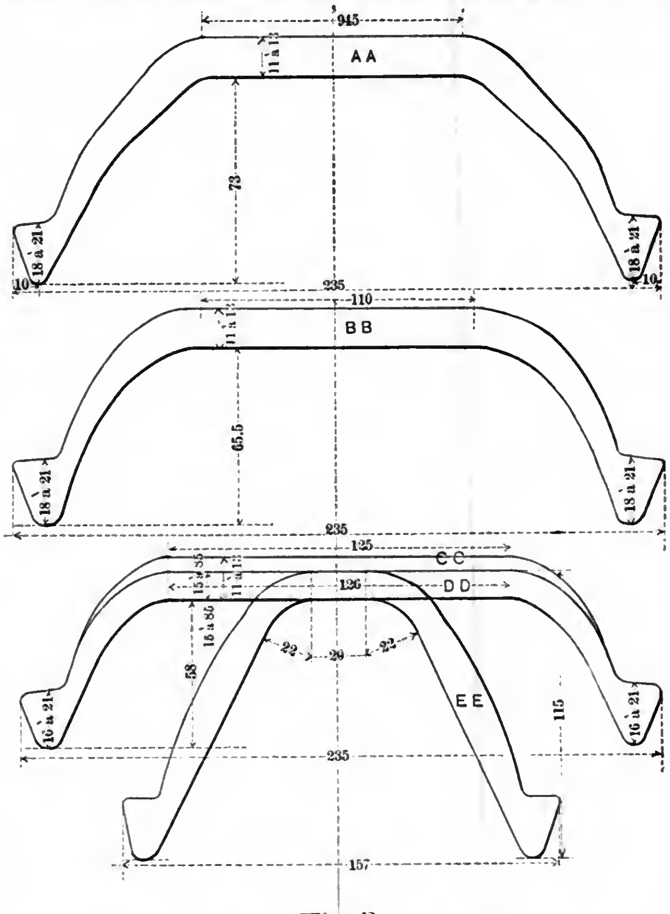


Fig. 3

(*Measurements in millimeters.*)

of the track. The reduction of size in the center of the tie, while diminishing the reaction of the ballast at that point, will result in keeping the principal resistance at the outside near the rails. At the same time, the increase of height at the end of the tie increases considerably its stiffness, and keeps it from bending while being transported to the road or in a neglected track.

The rails, which weigh 40 kilogrammes to the meter (80 lbs. per yard), are secured to the ties by clips or washers, of a form shown in the cut, and by bolts with Ibbotson nut-locks.

We will now see under what conditions the experiments with steel ties are made.

A model section of 576 meters (1,890 ft.) long on the modified Post ties of steel, with rails 12 meters long and weighing 40 kilogrammes per meter, is placed between another section of the same length (576 meters) laid with rails 33.7 kilogrammes to the meter (68 lbs. per yard), and 9 meters long, on Post steel ties of the old pattern, 10 ties to each length of rail, and a standard section 576 meters long, with rails of 40 kilogrammes to the meter and 12 meters long, laid on oak ties presenting 10 centimeters of

bearing to the rail. Each of these ties is furnished with two barbed spikes of the Post pattern. This last standard section on wooden ties is followed by another section of 576 meters in length, with rails 33.7 kilogrammes to the meter, and 9 meters long, on steel ties of a rectangular section.

These different sections are on a grade of 1 in 676, and are all ballasted with fine gravel.

From the preceding statements it will be seen that each model section of the track is placed next to a standard section of road, of the same nature from the point of view of the road-bed, the place and the travel being under conditions identical, or, at least, very closely similar. This trial, which is now actually in progress in Holland, is then a strictly comparative one for track upon metallic ties and track upon wooden ties, and it will lead, with the trials which the same company has been making since 1880, on its Liege-Limbourg line, to results which should be absolutely sure and conclusive.

Experiments made in so intelligent a manner will necessarily have very great interest for railroad managements which intend to introduce metallic sub-structure on their lines, and we propose to follow them very closely, in order that we may be able finally to complete the present notice by an announcement of the results obtained.

It remains that we should state the work which these different sections of road have to do, and indicate the cost of the track on the Post modified plan. Thanks to the kindness of M. Post, the Engineer, we have ascertained that the total number of trains passing daily from Tilbourg to Breda is 22, of which 14 are passenger and 8 freight trains. The maximum speed is that of the mail train, which may be estimated at 75 kilometers ($46\frac{1}{2}$ miles) an hour. As to the weight of the heaviest train, it is about 978 tons, or, perhaps, with the engine and tender, 1,046 tons.

The cost of the track upon metallic ties of the modified Post type is about as follows, the weights given being in kilogrammes:

Material for 12.007 meters of track, Post modified type.

	Weight. Each.	Total.
2 Steel rails, 12 meters long, 40 kilogrammes per meter..	480.000	960.000
2 Steel joint-plates, inside	10.270	20.540
2 " " outside	10.260	20.520
14 Steel cross-ties	60.000	840.000
56 Clips, wrought-iron	0.435	24.360
56 Steel bolts, with Ibbotson nut-locks	0.756	42.336
8 Steel joint-bolts, with Ibbotson nut-locks	0.768	6.144
Total weight		1,913.900
Weight per meter		159.399

The cost of the materials delivered at Breda was 20.39 francs per meter ($3.60 per yard). The cost with clips of steel, ordinary bolts and Verona nut-locks was 18.89 francs per meter ($3.33 per yard). The cost of road on the standard Post tie of the old pattern was 15.54 francs per meter, the total weight of material being 132 kilogrammes per meter. (The Post improved tie weighs $132\frac{1}{4}$ lbs. without clips or bolts.)

We understand that the use of the Ibbotson nut-lock increases by about 8 per cent. the price per meter of track, and by about 13 per cent. the cost of the tie with its attachments. So far, the new tie has shown very good results and has left nothing to be desired in the way of stability. It is with difficulty that, when a train passes, the slightest movement of the ties can be noticed, so well are they anchored in the ballast. On the other hand, if one can judge, the cost of maintenance appears to be much below that of ordinary track upon wooden ties.

It will, however, be possible to decide definitely upon this only after a much longer experience.

The company operating the Netherlands State railroads deserves a great deal of credit for its resolution to solve the important problem of metallic sub-structure; efforts which have already much advanced our knowledge on this question. Special credit is due to M. Post, Engineer of the company.

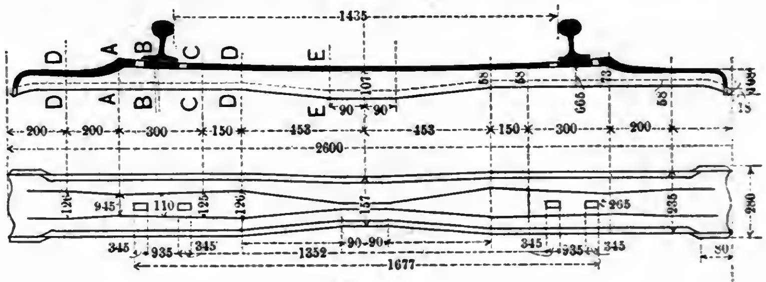


Fig. 2

(*Measurements in millimeters.*)

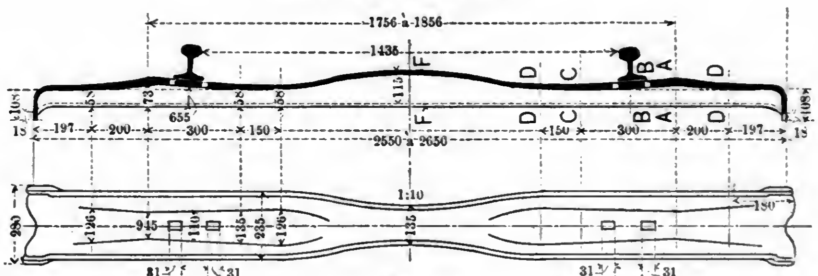


Fig. 4

We understand that this gentleman is now designing a new form of his tie, which he calls a tie of the "dromedary" form. In this form of tie (fig. 4), the under surface, which is imbedded in the ballast, forms a straight line, and the top of the tie is raised or arched in the center in such a way that this central part never finds a point of support upon the ballast.

The tie above referred to as the modified Post tie is shown in figs. 1, 2 and 3; fig. 1 showing the position of the rail upon the ties; fig. 2 a longitudinal section of the tie upon a much smaller scale, and fig. 3, cross sections of the tie at various points of its length. Fig. 4 shows a longitudinal section of the new or "dromedary" pattern of tie.

The Netherlands State Company intends to put in its track, by way of trial during the present year, about 8,000 ties of the "dromedary" pattern, and it will also try several thousand clips or washers of cast-steel, which have thus far given better results, although the price is much lower than those of wrought-iron.

Note On the Formation of Coal from Mine Timber.

[Read before the American Institute of Mining Engineers, by Mr. E. S. Moffat, of Scranton, Pa.].

MEMBERS of the Institute who have visited the works of the Lackawanna Iron & Coal Company at Scranton will remember the exposure of a large vein of anthracite coal in the rocky bank on the south side of Roaring Brook, near the blast-furnace. The vein is quite flat, and

is exposed to view for several hundred yards along the banks of the brook, a few feet above the surface of the water. It is some 10 ft. in thickness, and is known as the Big Vein. At a point just opposite the blast-furnace, much of the coal from this vein was mined out many years since, the usual pillars being left to support the overlying rock and drift, which are here some 25 to 30 ft. in thickness.

Over 30 years ago fire was communicated from an ore-roasting pile on the surface of the ground at this point, through an old shaft, down to the refuse and pillars which had been left in the mine below. Ineffectual attempts were made at that time to extinguish the fire, and it was finally decided to seal the mine up and smother the fire by the exclusion of air. All the openings were walled up tightly, and the mine was left undisturbed until a couple of years ago, when it was thought best to open it again and examine its condition. It was found to be still smouldering, and the fire burned up briskly as soon as air was freely admitted. Systematic measures were then taken to extinguish the fire by deluging it with water, and by working around it and cutting off any further progress.

In working through one of the piles of mine-refuse, which filled the vein from floor to roof in some places, the miners came upon a wooden mine-prop which had become curiously altered. The lower part of the prop was well-preserved wood, showing little evidence of heat. Half way up it was somewhat charred externally; above this, for some distance, it consisted of extremely soft charcoal, which crumbled at the touch. It then shaded into hard charcoal, and at the top, where it showed evidence of great compression, it was changed into a material resembling mineral coal in appearance. The change was even more marked in the wooden wedge which was on the top of the prop. In this the fibrous structure was still quite apparent, but the cross-fracture was sharp and conchoidal like that of anthracite coal, the color jet black, and the luster very bright and glassy. Its specific gravity was 1.38, and its hardness the same as that of anthracite. It burned with a feeble flame, and it was thought that it might be anthracite. Analysis, however, proved that such was not the case.

An analysis of pieces of the prop and wedge, made by Mr. A. H. Sherrerd, shows as follows:

Moisture at 100° C	5.65
Volatile matter	43.05
Fixed carbon	51.00
Ash	0.30
Total	100.00

An analysis of other fragments of the same material, made by Messrs. Booth, Garrett and Blair, gave the following results:

Water at 212° F.	6.793
Volatile matter	41.547
Fixed carbon	51.400
Ash	0.260
Total	100.000

This prop was imbedded in a mass of mine-refuse, slate, culm, etc., and the weight of the roof had crushed down the prop until the roof-rock rested upon the pile of refuse. At this point in the mine the fire did not get into the lower part of the "gob," but burned a little near the top. The conditions, then, which produced this alteration in the upper part of this prop were: very heavy pressure from the superincumbent mass of rock, and a smouldering heat, with exclusionof air for a period of over 30 years.

Railroads in China.

(From the *New York Herald*.)

OUR Washington advices contain two significant dispatches from the American consuls at Tien-Tsin and Newchwang, China. Mr. Bandinel, the Vice Consul at Newchwang, refers to the floods recently prevalent over the extreme northern districts of China. In some of the villages half of the dwelling places had been swept away. The deaths from starvation were numerous, and the people were reduced to eating grass grown for feeding cattle. Mr. Smithers, the Consul at Tien-Tsin, reports that a proclamation had been issued by Li Hung Chang, the Viceroy of the Northern Provinces, in which Pekin, the capital of China, is situated, directing the building of a railroad 100 miles long.

There is an essential relation between these two stories which would have made an impression years ago upon the minds of any statesmen less conservative than those who govern China. If the railroad which Li Hung Chang now contemplates had been in operation between Newchwang and Tien-Tsin there would have been no such famine as that reported by Mr. Bandinel. Food could readily have been transported from the Shanghai and other districts, where there is no such liability to floods as exists in the wide, open, frost bounds plains which sweep into Mongolia and upward toward Siberia and the North Pole. There is scarcely a spring when we have not, from Northern China, reports as distressing as those now printed by the Department of State. In the interest of humanity, therefore, it will be a gratification to know that China has ventured upon the policy outlined in the proclamation of the Viceroy Li, and that famines will not be imminent with the floods of every recurring spring. The high position of the Viceroy, the foremost subject of China in rank and authority—the Bismarck of the Empire, as it were—gives special value to his mandate.

The proposed railroad, Mr. Smithers informs the Department of State, is to connect Tien-Tsin, Taku, and Kaeping. This road will hold the same relation to the future railroad system of China as a road from Philadelphia to Cape May would hold to the present railroad system of the United States. Tien-Tsin, a city of about 800,000 inhabitants, is the commercial metropolis of Northern China and virtually the gateway to Pekin, the imperial capital, some 80 miles in the interior. Tien-Tsin is about 100 miles from the sea, at the head of navigation on the Taku River. Taku is a small collection of hamlets at the river mouth, and will be remembered as the scene of the hostilities between China and Great Britain which led to the opening of Pekin to the foreign legations. Kaeping is a coal mine, about 40 miles from Tien-Tsin, where there is already a small experimental railroad, built some years ago by the present Viceroy. The railroad proposed by Li Hung Chang will run over a low, alluvial, seaboard country, rich in agricultural resources, and probably touching the vast coal and iron deposits of the Chihli provinces. It will, however, only connect Tien-Tsin with the seaboard for the summer months, as in winter the northern provinces of China are locked in frost and ice. As it now is, after the ice sets in it takes the mails 18 days to go from Shanghai to Pekin on ponies—a distance traversed in four days when navigation is open. It will require a railroad of 800 miles to bring Tien-Tsin within all the year round seaboard communication. The nearest navigable point to insure this would be either Chefoo or Chinkiang, the Gulf of Chihli not being navigable in winter.

If Li Hung Chang succeed in building his Tien-Tsin & Taku Railroad without any interference from the gods of the winds and the waters, or various occult influences which have so often disturbed Chinese enterprise and statesmanship, we may expect a trunk line from Pekin to Shanghai along the line of the Grand Canal—say, in round numbers, about 1,000 miles. This would be equivalent to a line from Boston to Richmond. The second line would be from Shanghai to Canton, which would be like from Richmond to New Orleans. The third to Hankow—the Chicago or the St. Louis of interior China. It is quite probable that these three grand trunk lines, as the skeleton of the proposed system, are in contemplation, and that what Li Hung Chang now contemplates is but an experiment to familiarize the rulers and people of China with railways before venturing upon his greater work.

If the Viceroy is supported in his purposes and the aims of his proclamation are realized, then this news from Mr. Consul Smithers is the most important intelligence we have printed for many a day. We know of no event that can have so great a bearing upon the future of Asia, and in time, by the laws of political economy, upon that of Europe, than the opening of this vast Chinese Empire to railroads and the radical, sweeping forces of civilization

which are sure to follow. From the time of Mr. Burlingame it has been the policy of the American government, as represented by our ministers in Pekin, to urge railroads upon China. In the Burlingame Treaty special reference was made to the subject, and nothing but the traditional conservatism of the Chinese character, together with economic problems of the gravest kind, occasioned by the density of population, and the social dangers that might arise from the unavoidable interference by railroad operations with ancient and accustomed methods of transportation and industry, has prevented railroad building. In 1884, however, when China was at war with France and on the verge of a war with Japan, which the friendly advice of President Arthur did more than anything else to prevent, the Viceroy, Li Hung Chang, realized the weakness of the Empire because of the absence of a railroad system. He then communicated to the American Government his resolution to adopt railroads as soon as peace gave breathing time to China. We are glad to learn that he has held to this resolve and made a beginning.

Underground Telegraphy in England.

[Paper read before the Society of Electricians and Telegraph Engineers, London, England, by Charles T. Fleetwood.]

In the year 1816, Mr. (afterward Sir Francis) Ronalds laid his first experimental line underground, in his garden at Hammersmith, and convinced himself, at least, of the practicability of establishing telegraphic communication by means of insulated wires placed beneath the earth's surface. A small book published by him in 1823, entitled "Description of an Electric Telegraph, and of some other Electrical Apparatus," gives a full account of the experiments referred to. A trough of wood about 2 in. square, well lined inside and out with pitch, was placed in a trench 525 ft. long and 4 ft. deep; lengths of stout glass tube were joined together by means of shorter lengths of similar tube of somewhat greater diameter, the joints being made with soft wax to allow for expansion and contraction caused by the variation of temperature. A copper wire was drawn through the glass tube, and the tube was imbedded in pitch, the covering being screwed down while the pitch was hot. Mr. Ronalds further suggested that wires should be buried in iron troughs, in trenches 6 ft. deep, in the middle of the high roads, and if there was any fear of the communication being interfered with by any mischievous person or persons, two different routes should be chosen. Testing stations should be established along the route, and linemen stationed at these points ready to start out after faults at any moment, should there be a necessity for so doing. He recommended that offices should be opened all over the country, and evidently foresaw the immense advantages that would be derived by the Government, as well as by the commercial world, in the employment of what he considered so "diligent a courier" as electricity.

Messrs. Cooke and Wheatstone took out their first patent in 1837, for "Improvements in giving signals and sounding alarms in distant places, by means of electric currents transmitted through metallic circuits." In this patent they included a plan for laying down subterranean wires, and in the same year established communication between Euston Square Station and Camden Town, by means of five copper wires let into five grooves cut longitudinally in a piece of timber, the wire being covered with cotton and passed through a preparation of resin, and after being placed in the grooves, tongues of wood were placed over them to make all secure, and the whole was then covered with pitch and buried in the earth, between the above-named points.

The second patent taken out by these pioneers included placing wires, made up into cables, in iron piping; this was in 1838. During the following year a line of five wires in an iron tube was put down on the Great Western Railway from Paddington to West Drayton, and afterward on to Slough.

Conductors, covered with cotton and passed through different solutions, were tried in a variety of ways, some being suspended and others buried in pipes, but very great difficulties were experienced in preserving the dielectrics; weak places, being traced, would be repaired with India-rubber tape and a solution of the same material. This kind of work was being done near the Stepney Station, on the Blackwall Railway, when Mr. Hatcher—then Engineer to the Electric Telegraph Company—introduced to the lineman a piece of lead tubing containing several wires covered as above.

The first line of wires erected upon poles for commercial purposes, was from Nine Elms to Gosport; this was before the London & Southeastern Railway was extended from Nine Elms to Waterloo Station. The Electric Telegraph Company opened its first office at 345 Strand, and decided to lay the wires underground from that point to Nine Elms Station. Two lead tubes, about ½ in. in diameter, covered with tarred yarn, each tube containing four copper wires wrapped with two layers of thick cotton, and the tube filled with a mixture of tar, resin and grease, were drawn into a 3-in. cast-iron socket pipe. The lead tubes were originally 150 ft. in length. After the wires had been joined, a piece of lead tube of larger gauge, encircling the pipe, was drawn over the joints and soldered at each end. A portion of this tube, recently dug up, was found to be in excellent condition, the tar being quite fresh.

In the year 1843, a specimen of gutta-percha was first introduced into England by Dr. W. Montgomery, but up to 1845 only a few hundredweights had been exported from Singapore. Since that date many thousands of miles of wire have been covered and buried beneath the surface of the earth, or submerged in the sea. The quantity of gutta-percha imported into London alone during the three years ended December 31, 1886, amounted to 6,700 tons. Messrs. Keene & Nickels received a small quantity of gutta-percha from Singapore during 1845, and this appears to have been the first imported into England. This firm ultimately sold their patent for processes in working gutta-percha to the Gutta-Percha Company, Wharf Road, City Road.

During the following two years Mr. Hancock took out patents for cutting, cleansing and pressing gutta-percha through rollers; but no mention is made of covering telegraph wire in any patent up to the end of 1847.

To Professor Faraday credit has been given for having announced that gutta-percha was an excellent dielectric, and in the beginning of 1848 patents were taken out for covering wires with it. The first patent taken out in England for this purpose, so far as I can learn, was by Messrs. Barlow and Foster, the plan suggested being as follows: The wire was placed between two heated fillets of gutta-percha, and made to adhere by passing between two rollers. In the same year, Mr. John Lewis Ricardo, Chairman of the Electric Telegraph Company, patented a machine with a pair of grooved rollers, through which the wires passed, placed parallel between the fillets, the action of the rollers being to bite nearly through the gutta-percha and allow of the several wires so covered being easily separated.

These early machines did not do their work with the same regularity as those in use at the present time, for it frequently happened that instead of the covering being smooth and uniform, it was found to be thicker at intervals—so much so, that it had to be pared down with a sharp knife.

The directors of the Electric Telegraph Company, having discovered that the Strand was not the best position for their chief office in London, resolved to build a central station at the end of Founders' Court, Lothbury. This was formally opened January 1, 1848. From this office a circuitous line of 3-in. cast-iron socket pipes was laid, chiefly under the footways.

When these pipes were first laid down, wires covered with cotton, passed through one of the preparations in use prior to the introduction of gutta-percha, were drawn into the pipes; but for these wires were soon substituted the wires covered with gutta-percha.

The first section of line in London into which gutta-percha-covered wires were drawn was from Lothbury to Shoreditch, in 1849; and this was followed by the line to Euston and King's Cross. The wires that were first drawn

in were covered with gutta-percha by one of the processes already described, and failed, owing to the gutta-percha seam opening longitudinally and exposing the conductor.

At this date a large number of experiments were made; wires of iron, brass and copper were covered with gutta-percha; in some cases single wire, in others three wires, and as many as seven wires were enclosed in a solid core. Great improvements were rapidly introduced, and copper wire of No. 16 B. W. gauge was covered with solid gutta-percha of excellent quality, up to No. 1 and 3 gauge; and by August, 1854, no less than 15 miles of pipes, containing 350 miles of wire insulated with gutta-percha, had been put into working order in London alone for the Electric Telegraph Company.

The pipes used by this company were of cast-iron, 3 in. in diameter, and cast with a flat surface on one side, upon which were the initials E. T. C. Across Hyde Park the pipes were of earthenware, the joints being made with clay.

In 1850, the success of the Electric Telegraph Company induced some enterprising capitalists to form rival companies, one of which—the Submarine & European Telegraph Company—laid a line of six gutta-percha covered wires from London to Dover. This line was completed by November 1, 1852. In 1853, the British Telegraph Company commenced burying six gutta-percha covered wires along the high roads from London to Liverpool, via Birmingham and Manchester, the latter place being reached by March 1, 1854, and Liverpool during the same year.

The Magnetic Telegraph Company, in 1853, laid 10 wires as far as Liverpool, and 6 wires between Liverpool and Portpatrick. Underground wires were also laid between Cork and Queenstown.

These wires were buried in a wooden troughing of about 3 in. outside, with a groove about 1 in. square, having a lid of the same material; this was fastened down with nails after the wires had been placed in the troughing. The iron troughing was of about the same dimensions externally, but, of course, allowed more space for the wires inside; the lids were of iron.

When cast-iron pipes were used in towns, they were very similar to the iron troughing, being cast in two pieces; they were patented by both Mr. Reid and Mr. Henley, and are known as Reid's & Henley's split pipes. The wires were in some instances laid in troughing without any protection beyond the gutta-percha, but in other cases they were protected by two layers of tarred yarn laid on in opposite directions. The whole of the stores appear to have been of the very best quality.

The underground line of the Electric Telegraph Company, laid along the side of the London & Northeastern Railway, from London to Manchester and Liverpool, was somewhat different from those just described. The pipes were of earthenware, the joints being made with clay. At intervals of 150 ft. split earthenware pipes of larger diameter were fixed, to allow of the wires being drawn in. An iron wire was passed through the pipes as they were being put together, for the purpose of drawing the cables through.

From London to Watford four wires only were drawn in, but these had to be increased to eight, which number was continued on to Liverpool.

The work of constructing these different systems was finished by the beginning of 1855, and, after a very short life, in 1857–58 they were condemned, and wires on poles substituted. This applied to all the underground lines laid from London to the provinces in 1853.

When the greater portion of the wires were taken up in 1857 and 1858, a few sections were allowed to remain, especially in and near London. Portions of these lines have been recovered at different periods, in different localities, and under various circumstances. Some of the gutta-percha wires, that have been buried for more than 30 years, are now in first-class condition, but where this is the case they have been found wrapped in two layers of tarred yarn, and laid in iron casing or split pipes. The same cannot be said of that found in wood troughing, except under special surroundings. There is every reason to believe that the gutta-percha used to cover these wires was the real material, and was not subjected to anything akin to the so-called improvements in manufacture of late years.

Although the insulating material was good, yet there were many faults in the wire previous to its being buried. Probably owing to some fault in the machinery used for covering the wire, the copper wire got elongated and pressed in the form of a loop through the gum; many such places were discovered when the wires were recovered and examined.

The wire used by the Electric Telegraph Company on the London & Northwestern Railway was covered with gutta-percha, and then each wire was served with tape. After this wire was delivered on the railway at Watford, it was passed through a bath of hot tar and sand; while the drums were moving at a regular pace, a serviceable jacket of tar and sand was given to the wire, but when anything happened to interrupt the continuity of this operation the portion left in the bath was exposed to a temperature sufficient to melt the gutta-percha, and the wire passed out covered with tape, tar and sand only. Adequate care was not exercised in protecting the wire from the heat of the sun, it being allowed to remain lying on the banks of the railway uncovered for a considerable period, so that the copper wire got out of the center, and in some cases became exposed altogether. After the cables had been put in place, the drawing-in holes at every 150 ft. were left uncovered, and the ends of the wires left exposed waiting for the jointers to come and make the permanent joints, and the split couplings to be put on.

The means adopted to preserve the wires were defective. Knowledge derived from a series of observations points to the fact that split pipes, whether of wood or iron, are not equal to the requirements of a subterranean line of telegraph wires. Wood troughing is subject to dry rot, and, therefore, various expedients have been resorted to with the view of preserving the timber; but some of these preservers act injuriously upon the wire, causing the insulation to be destroyed. When the line is placed near to trees, especially oak trees, the surrounding moisture is absorbed for a considerable distance; this applies to lines constructed of either wood or split iron pipes. Special circumstances may arise that would make it expedient to use wooden troughing, but where there is an absence of such special conditions solid cast-iron pipes are to be preferred. In London, split pipes are a source of danger, for, since the chief thoroughfares have been paved with wood or asphalt, the gas that escapes in considerable quantities from the gas companies' mains accumulates under the surface and finds its way into these half-pipes, and thence into our junction boxes, causing much annoyance and inconvenience. I have known cases where the accumulation of gas, collected through split pipes, has been so great that it has been necessary to open the box some minutes before the jointer could light his lamp with safety.

Where earthenware pipes have been used instead of iron, it has been done for economical reasons only. Such a line was laid some years ago from opposite St. George's Hospital, Knightsbridge, across Hyde Park, to Tyburn Gate, the joints being made with clay. Another section of the original line laid in 1851 between the site of the exhibition of that year and the Serpentine Bridge was of earthenware. Some years ago the 16 wires that were drawn in when the line was laid, had to be drawn out to allow of the number being increased. Much difficulty was experienced in moving the old wires, and it became necessary to break one, and by laying it over the trench to trace the locality of the obstacle; when this was done, and the ground opened, it was found that the root of a tree, about 10 ft. long, had found its way through the clay with which the joints of the pipes were made, and had entwined itself around the cable in such a manner as to hold it fast. I need scarcely say that the gutta-percha had entirely perished at this point. Pipes of this description are always more liable to be damaged by the operations of the gas, water or hydraulic power companies' workmen, when opening the ground to get to their mains, than solid cast-iron pipes.

Another, and I think the chief, cause of the rapid decay of the lines referred to, was the rapidity with which the work was carried out. All the companies were racing to

get through to the provinces as soon as it was possible, and there is no doubt that this led to the work being done without the necessary supervision being given.

At the present time it is found necessary to place experienced men to watch the work as it proceeds, for where this has not been done the work has proved to have been unsatisfactorily carried out. When this is taken in connection with the fact that the majority of the men employed on these works were totally ignorant of the necessity of the greatest care being exercised, and the utter impossibility of the few able men to be everywhere along the works at the same time, it is not surprising that these early lines had to be so soon abandoned.

We now come to a very important epoch in connection with the telegraph systems of this country—the transfer of the telegraphs to the Post Office. This took place in the beginning of 1870, when all the different companies' lines were diverted to the central office of the Electric Telegraph Company in Telegraph Street, Moorgate Street. This work was carried out under the direction of Mr. Henry Eaton, now the Superintending Engineer of the Metropolitan District.

After the concentration had been effected it was soon discovered that nearly all the lines, with the exception of those in solid cast-iron socket pipes, were deficient in insulation; and, as the various methods of construction did not provide for renewals to be made without opening the ground, they were gradually abandoned, and the number of wires in the 3-in. cast-iron socket pipes of the late Electric Telegraph Company increased to meet the ever-expanding requirements of the service.

Previous to the completion of the new Post Office in 1874, the pipes and wires passing north, south, east and west of the new building were led through the basement and up to the instrument gallery, where they terminated in a very extensive test-box, the terminals being numbered from 1 to 1,000.

The change from the old office having upset all the numbers in the joint-boxes in the streets, it was considered necessary to renumber the whole, and thus make the numbers in the boxes correspond with the new test-box. This was carried out so perfectly that the whole of the circuits were diverted to the new office in a very few hours on the night of January 17, 1874, without the slightest interruption to the ordinary traffic.

At this date the length of pipes in the Metropolitan District was about 100 miles, and the total length of wire in the pipes was 3,000 miles. Shortly after this time an agitation was started against the over-house wires, and it was decided by the Post Office authorities that a new line of 3-in. cast-iron pipe should be laid down, and 100 miles of wire drawn into it, in place of 126 miles of over-house wire.

This was the first piece of work carried out in London with the view of reducing the over-house system belonging to the Post Office, and this was supplanted by others, until all the main lines of over-house wires had been removed.

The chief portion of this work was finished before the introduction of the telephone, which must be held accountable for the damages apprehended from the extraordinary network of wires suspended over the chief thoroughfares of the city, and to a lesser extent the suburbs, of London. It has had also the effect of largely increasing the mileage of underground wires, for it was soon found that, for a telephone to work well underground, two wires must be used instead of one, and after many experiments it was found that much better results were obtained by the use of four-wire twisted cable covered with tape, two of the wires being used diagonally for the telephone circuit, thereby overcoming the effects of induction. Twenty of these four-wire cables, equal to 80 conductors, are now generally drawn into one 3-in. cast-iron pipe, some of them forming part of the original lines laid down 40 years ago, in 1847; judging from what I have seen when the wires were drawn out for increasing, there is no reason to think that they are likely to give trouble for many years to come.

At the beginning of 1880, an experimental line of 1⅜-in. wrought-iron pipe and 30 No. 18 B. W. G. copper wires, each covered with manilla, and the whole made up into a cable and covered with a braid of the same material, was laid for the Post Office under the direction of the patentee, Mr. David Brooks, of Philadelphia, the insulation being obtained by filling the pipe with oil after drawing in the cable. After this line had been completed, the wires, with one or two exceptions, gave very good results as regards insulation, but from the first there was a very great loss of oil, and this continued more or less, although every effort was made to trace and repair the leaks. Although the cost of construction and maintenance has been very heavy, it appears to me that this system is worth a further trial under more favorable conditions; for instance, along a country road, where it might form part of a through line, and where the pipes would not be subject to such frequent disturbance as in the crowded streets of London.

Several very large extensions to the boundary of the Metropolitan District, and even beyond it, as well as the great increase in wires for private use, have increased the mileage from 100 miles of pipe and 3,000 miles of wire in 1874 to 240 miles of pipe and 12,000 miles of wire; an average of 50 wires through the entire length of pipes. The total weight of copper buried in the Metropolitan District amounts to over 200 tons, and that of gutta-percha to 250 tons.

In the main thoroughfares near the General Post Office the wires are very numerous. Thus, through Little Britain there are two 3-in. pipes containing 109 wires; Aldersgate, two pipes, 160 wires; Gresham Street, two pipes, 150 wires; Cannon Street, two pipes, 168 wires; Cheapside, one 4-in. and two 3-in. pipes, and 242 wires; Ludgate Hill, one 4-in., three 3-in. pipes, 350 wires; Newgate Street, two 4-in. and three 3-in. pipes, with over 400 wires.

These numbers have been reached through gradual increments, the practice being to put into a new pipe as many wires as are actually required for the special service, with a small percentage of spare wires, and as soon as these have been appropriated for new circuits, to increase the number by drawing out the existing wires and replacing them by a cable with additional conductors. This class of work is continually being carried out in different parts of London, to meet the great increase in telegraph and telephone business.

During the last 15 years nearly every section of line has been disturbed, either for the purpose of removing faults which sometimes trouble us in or near the flush-boxes, through the necessarily frequent exposure of the gutta-percha to variations of temperature caused by the linemen getting new wires through, etc., or by the necessity of increasing the number of conductors, as occasion may arise. So much of this work has been done that it would be difficult at the present time to point out any portion of line that has not been interfered with during the above period.

The advantages of being able to replace the working wires by a greater number without seriously interrupting the communication must be evident to all; but this is easily accomplished where the lines are constructed of 3-in. cast-iron socket pipes, with boxes either fixed flush with the surface or buried beneath the pavement at intervals of 150 to 300 ft. according to the size of the cable to be drawn in.

After many years' experience, and with a full knowledge of the many schemes which inventors have brought forward from time to time, I do not know of any plan which can be compared with the present system for simplicity, utility and durability.

Standard Sizes of Lumber for Freight-Cars.

THE following report was presented at the Master Car-Builders' Convention in Minneapolis by a Committee consisting of Messrs. William Forsyth, Frank J. Hecker and W. R. Davenport:

In recommending a few standard sizes of lumber for the principal members of freight-car frames, the Committee

does not expect to change existing dimensions on many of the larger roads. Its principal object is to present to the railroad public a bill of material which this Association can recommend to new roads having no adopted standard, and to other roads which are about to change from 30,000 or 40,000 lbs. capacity to a car of larger capacity. It is the hope of the Committee, therefore, that the larger roads having standard sizes which they do not intend to change will not oppose a measure which will do them no harm in the matter of car interchange, and may do others much good.

The principal advantage which railroad companies would derive from uniform sizes of car lumber is the use of dry, seasoned lumber on contract cars.

By far the largest number of freight cars are now built by contract in the individual shops. When cars are built by the railroad companies in their own shops, the lumber is taken from their own yard, where the standard sizes may be kept on hand several years, and when used it is thoroughly seasoned. With the present diversity of sizes for the frames of cars for the different roads, it is almost impossible for the contract shops to keep in stock such a variety of lumber as will suit any order they may get. The result is that in most cases the lumber is not bought until the order is secured for cars, and it frequently happens that it is not *sawed* until that time.

It is not an uncommon practice to build cars from lumber which a month before was in the mill-pond in the form of logs.

The evil effect of this practice is well known to car-builders, and it is undoubtedly the worst feature of contract cars. As the lumber dries and shrinks in the car the whole frame becomes loose, and the life of the car is materially reduced not only by the working of loose joints, but by the premature decay of the lumber itself, when it is put together and painted before it is dry.

It is a well-known fact also that kiln-dried lumber is not as strong as seasoned lumber, and it will rot quicker.

If standard sizes were adopted, the contract shops could keep on hand a sufficient stock of lumber to allow it to season one or two years, and the railroads could then obtain by contract a much better car than they usually do.

It is possible to specify a certain maximum amount of moisture in car lumber, and to obtain lumber to such specification, by measuring the amount of moisture in sample borings.

The borings from about a cubic foot of wood are placed on a vial and weighed on a chemist's balance; they are then evaporated to dryness and weighed again, the per cent. of loss noted representing the water driven off. In this way the fluctuation of moisture during the process of seasoning has been obtained for oak, ash and pine, and it is shown in the diagram which accompanies this report.

Green oak as received in the yard contains 45 to 50 per cent. water, and after a year's seasoning it still contains over 30 per cent. Norway pine from the mills contains over 25 per cent. water, and a year's seasoning reduces it to 10 or 12 per cent. Pine should be seasoned at least one year, and oak two years to avoid excessive shrinkage and early decay. The amount of water in lumber may be taken as a direct measure of the length of time it has seasoned.

The majority of cars now building are 34 ft. long, so that one dimension of the long sills may be regarded as settled for the time. New equipment is also largely centering about a capacity of 50,000 lbs., and we recommend sizes suitable for that capacity. These sizes are not extra large for cars of 40,000 lbs. capacity, and they are sufficient for one of 60,000 lbs. The additional strength required for the latter can easily be obtained by the use of a deeper truss made of iron of larger diameter.

We, therefore, recommend the following bill of lumber for principal members of car body for 34 ft. box, stock and flat cars, capacities 40,000 lbs., 50,000 lbs. and 60,000 lbs.:

Under Frame:

Six long sills, 5 × 9 in., finished Norway pine.
Two end sills, 7 × 9 in., finished oak.
Two cross ties, 4 × 9 in., finished oak.
Four draw timbers, 4½ × 7½ in., oak.
Flooring, 1¾ in. thick, 5 to 10 in. wide, Norway pine.

Upper Frame:

For the same cars as above, excepting flat cars:
Eight door and corner posts, 4 × 4½ in., finished oak.
Twenty-four pieces, intermediate posts and braces, 4 × 3 in., finished oak.
Two end plates, 3 × 12 in., finished oak.
Ten carlines, 1¾ × 9 in., finished oak.
Two side plates, 3 × 7 in., finished Norway pine.

We recommend also that the above sizes be submitted to the Association for approval by letter ballot, as standards for freight-car lumber.

Robert Hale's Machines for Cutting and Bending Metal Bars.

AMONG the visitors at the convention of the Master Car-Builders' Association, held in Minneapolis in June, was the venerable Robert Hale, who for a number of years was the General Superintendent of the Chicago & Alton Railroad and who before that time occupied responsible positions on other roads. He is now Secretary of the Board of Trade in Minneapolis, but like all ex-railroad officers, he is still enterested in the profession of his earlier years.

Mr. Hale is the inventor and patentee of a machine for cutting and bending metal bars, such as truck-frames, coupling-links, etc., and several other devices to be used on railroads, including a safety car-heater. With reference thereto Mr. Hale writes as follows:

I inclose with this one copy of the work explanatory of the machine for shaping by pressure, straightening, etc. The work explains the merits claimed. Also official printed copies of the letters-patent covering the improvements (dated June 16, 1874, Aug. 28, 1877, Nov. 20, 1877). In addition, at the end of the book is attached a circular issued by me 10 years ago for an improvement in car-heaters, which was patented immediately after the Ashtabula accident, when so many lives were lost by the fall and the burning of the cars, as has been too frequently repeated in the past year or two. The improvements in the machine are covered by three letters-patent and the heater by one—four in all.

As a piece of professional liberality on my part, having devoted 35 years of my early business life to the management of railroads, in all the different departments of service, from the lowest to the highest, and having been intimately acquainted with most of the earlier generation (now nearly gone) of railroad officials and managers, and desiring to aid (even in a small degree) those engaged in the profession, and the interests they are so devotedly serving, I assigned the right (or donated the right) to the following roads, and will donate the same to any other roads that may desire to use the improvements.

The assignments (as per copy inclosed) give the right to any and all roads to *build* and use, but not to *build* or *sell*, neither to purchase of outside parties who have *not* obtained the *right* to *build*, as there are now parties who are infringing these patents at their peril.

The saving of expense to railroads by the use of these machines would in the aggregate be a large sum—but to me *personally* nothing. * * * * ROB'T HALE.

P S.—I will add that the patents for the machine were examined by the Secretary and Attorney of the Western Railroad Association, who reported that they did not infringe any patents previously granted and that they were *valid* patents.
R. H.

Assignments of R. Hale's Patents for Bending Machinery, etc., made to the following railroads—donated:

JANUARY 2, 1882.

1. Chicago, Milwaukee & St. Paul (4 patents) '79.
2. Chicago & Alton.
3. Illinois Central.
4. Chicago & Northwestern.
5. Chicago, Rock Island & Pacific.
6. Chicago Burlington & Quincy.
7. Michigan Central.
8. Lake Shore & Michigan Southern.
9. Northern Pacific.
10. Wabash, St. Louis & Pacific.
11. St. Paul, Minneapolis & Manitoba.
12. Chicago, St. Paul, Minneapolis & Omaha.
13. Pennsylvania, and leased lines.
14. New York Central & Hudson River.
15. New York, Lake Erie & Western.

JANUARY 5.

16. Atchison, Topeka & Santa Fé.
17. Central Pacific.
18. Union Pacific.
19. Baltimore & Ohio.
20. Boston & Albany.
21. Eastern.
22. Boston & Maine.
23. Old Colony.
24. Boston & Providence.
25. Boston & Lowell.
26. Concord, and Manchester & Lawrence.
27. Northern (New Hampshire).
28. Central Vermont.
29. New York & New England.

Late English Torpedo Experiments.

SOME interesting experiments made in torpedo attack and defence by the English Navy, recently, are described by the London *Times*, whose account is given below. The vessel was the old iron-clad *Resistance*, and the experiments were made in Fareham Creek, near Portsmouth.

As the machinery was not in use and there was no steam in the boilers, the effect of the jar upon the steam-pipes, glands and feed connections will remain a matter of speculation. So far as the consequences of the burst upon the structure of the hull itself is concerned, every care has been taken to make the ordeal as complete and instructive as possible. The wing passage, which has a *maximum* diameter of 3 ft., diminishing to a point, is left empty, although at the former experiments the lower portions were filled with coal. But behind this, and at a distance of 8 ft. from the wing bulkhead, a longitudinal or fore-and-aft steel bulkhead ⅜ in. thick, has been worked to a length of 61 ft., and, with the coal with which the intervening compartment is packed, forms (as in recent armor-clads) a solid rampart 20 ft. high, for the defense of the engine-room. The height of the double bottom between the outer and inner skin plating is 2½ ft. The water-tight compartments are divided into stations by means of vertical lightening plates pierced by three holes, and in order to make them, as far as was practicable, resemble the bracket frames of a modern armor-clad, the center of the plates was cut away so as to leave a single oval hole instead of the three circular holes previously referred to. So far no objection can be taken to the means adopted to test the actual effects of a torpedo exploding against the unarmored parts of a ship-of-war. But in extending and strengthening the under-water protection of the *Resistance*, the practical value of the experiments is discounted. As is well-known, Sir Edward Reed has suggested a means of meeting the attack of the ram and the torpedo by armor-plating the inner bottom. As to this device, Sir Nathaniel Barnaby has expressed his want of faith in its utility for the Navy after having seen the plan worked out by Sir Edward Reed. The ex-Director of Naval Construction was of opinion that the true defense for us against the increasing power of the under-water attack lay in numbers of ships. In view of the difference of opinion which exists on the part of experts on the subject of under-water protection, the officers of the *Vernon* determined to submit the problem to the test of experiment. For this purpose steel armor 1½ in. thick has been worked along the outside of the upper skin of the double bottom throughout one of the compartments, in addition to the other protection mentioned. But however desirable it might be to practically determine the value of Sir Edward Reed's suggestion, it is evident that it ought not to be subjected to experiment until the resisting power of the other defenses had been ascertained. We have no ships protected against under-water attack by armor-plating, and hence, by combining armor with the ordinary protection, the present demonstration as a test of the worth of the existing under-water structures on board ship loses much of its significance.

The *Resistance* has been brought down by iron ballast to a trim of 25 ft. 9 in. aft and 19 ft. 7 in. forward, giving a mean draught of 22 ft. 8 in. She is, consequently, rather further down by the stern than before, but is in other respects the same. When in commission the *Resistance* had a mean draught of 26 ft. 10 in. But however desirable it might have been to immerse her to her original load line, the thing was rendered impracticable from the want of water in the creek. The present series of experiments promises to be of even greater importance than the first series. The attack will be gradually developed by means of fixed and outrigger charges of increasing power, and the *coup de grace* will not be given by means of a service Whitehead torpedo in actual contact until various lessons have been derived. The opening experiments yesterday consisted of an attack directed against a new system of torpedo defense, which are to be carried by ships in action, or when in expectation of an attack, rather than an assault upon the ship itself. The previous experiments had clearly demonstrated that a Whitehead, when projected against a vessel at close range, and consequently with a *maximum* of motive force, could not get through the ordinary wire netting before expending its explosive energy in the air, and that the spars by which the nets are boomed out from the ship's side could be reduced to 25 ft. in length without danger to the hull. The ordinary wooden booms employed on board ship, however, are heavy and unwieldy, weighing as they do more than half a ton each. In ordinary circumstances the spars cannot be lowered into place and the nets made taut in less than a couple of hours, and the work of stowing them is equally slow and laborious. Mr. Bullevant, who manufactures the torpedo netting and hawsers for the Navy, has devised a method of getting rid of the difficulties complained of by substituting steel booms for the wooden booms and an arrangement of pulleys and runners, whereby the protection can be run out and in, topped and brailed up out of the way, with great facility. The system was tried at Portsmouth last year with considerable success upon the *Dido*, but as it was thought that some of the fittings were somewhat frail and might collapse beneath the shock of a live torpedo it was resolved to submit them to a practical test under service conditions upon the *Resistance*. The ship was consequently fitted with three of the steel booms on the port side. They were 32 ft. long and spaced 45 ft. apart, and connected by a jackstay to which the nets were attached. Each steel boom weighed 5 cwt., or less than half the weight of the ordinary boom, and whereas the latter is fixed to the ship's side by a hook which is liable to be disconnected or broken by the jerk of an exploding torpedo. Mr. Bullevant's boom works in a universal or socket joint, which cannot get out of gear except by fracture, and which permits the boom to be moved in any direction, whether vertically or fore and aft, close in against the sides. Below each boom is a flange, which serves as a line along which a traveler moves, the latter being actuated by means of a topping line running over a pulley at the head and another near the heel. Upon the booms being topped to a perpendicular position the nets are attached to the runners at the bottoms of the booms close inboard (instead of under the existing system to the tops of the booms from the boats alongside or otherwise), and when this is done the mere depression of the booms into position will cause the nets to run out of their own accord. In like manner, when the occasion for their use has passed, the rising of the boom will cause the nets to come alongside, when they can either be brailed up through the grummets or disconnected for future use. The action of the gear is so simple and rapid that the torpedo protection can be always ready without arresting the way of the ship. As a length of net 30 ft. by 20 ft. deep weighs about 30 cwt., it will also be seen that the reduction of strains by working the crinolines from the heel instead of the head of the boom is considerable.

The attack by the Whitehead upon the booms and nettings was made shortly before 2 o'clock, June 9, at the time of high tide. The proceedings were understood to be of a strictly confidential character, but facilities were granted to the dockyard officers and also to the naval and military officers belonging to the port and garrison to witness them, although no measures were taken to inform

them as to the nature and value of the experiments. The whole affair occupied a very few minutes. As soon as the red pennant was stuck on board to show that Mr. Bullevant was satisfied with the arrangements and that the target was ready, the antiquated torpedo vessel *Vesuvius* got under way, and, after circling around the doomed hulk, discharged a Whitehead against the netting from her under-water low torpedo tube at an approximate range of 50 yards. As on former occasions, the missile was one of the old 16-in. pattern, but it was understood that the charge of gun-cotton had been reduced to 87 lbs., so that the net protection should not bear a greater strain than would be the case in actual hostilities. The torpedo, which was set to a depth of about 10 ft., struck the net in the middle and threw up an immense spout of water, but without getting to the ship, which was apparently uninjured. Although it hit the net immediately below the center-boom, no fracture occurred, and the points remained intact. It may also be mentioned that, although at the short range the torpedo would spin through the water at from 30 to 40 horse-power, and would deliver a formidable blow upon the net, the thrust was effectually resisted, though as a matter of course the net was much torn by the explosion of the baffled projectile.

The second torpedo attack upon the *Resistance* was made June 10, and, although the offensive power that was brought to bear was quite exceptional, the victory so far remains with the ship. So unquestionably is this the case that the shipbuilding department are naturally elated, and even go so far as to doubt whether the torpedo officers will be able to destroy the old ship by any legitimate or other means susceptible of practical application in time of war. The hulk is perfectly motionless. The enemy can deliver his attack without interference on the part of the attacked, he can execute his operations in his own time, he can employ his most expert and capable torpedoists (professors of the art, in fact), he can use whatever charges he likes, and can place them just where he thinks they will do the most mischief. Nor must it be forgotten that the target in this instance is not a fresh one. It has been tattered and torn by previous conflicts with submarine enemies, and has had its honored scars plastered over on the inside by planking and other surgical artifices, and yet, with all these great advantages in favor of the attack, the *Resistance* continues not only afloat, but is to all appearance as tight as a bottle, with the exception that a few trivial runlets have managed to find a passage in the region of the old sores. The charge exploded yesterday was an exceptionally heavy one. It consisted of 220 lbs. of gun cotton. It was consequently more destructive than any which is ever likely to be launched against an armor-clad much better prepared to resist it than the obsolete and time-worn *Resistance.*

Mr. Bullevant's patent booms and runners, which were found to be scarcely anything the worse from the ordeal of the previous day, were again used. The damaged net was taken away, and one of the old service grummet nets slung in its place, the cylinders containing the gun cotton being attached to the jackstay immediately in front of the battered sides and 30 ft. from the hulk, and sunk to a distance of 20 ft. below the water-line, which would bring it about opposite the bend of the bilge. By 3 o'clock, or half an hour after the time fixed, everything was ready for the explosion of the charge, everybody had cleared out of the ship, while the surrounding small craft drew off to a distance of 300 ft. The charge was electrically fired from a pinnace. The burst was terrific, and the reverberation was heard and the shock distinctly felt in the dockyard. But the remarkable thing was that the hulk did not appear to jump in the least, although there was not more than 6 ft. of water under her keel. That she would not be seriously crippled by the discharge seems to have been accepted as a foregone conclusion by Captain Long and the other torpedoists, as the day for the third experiment had been fixed in advance, but that the steel booms, with their double-flange running ways, stays, travelers and hinges, should have resisted the tremendous jar and upheaval was a genuine surprise for all concerned, and goes far to prove that, except a vessel be taken unaware, it will be impossible for a torpedo to come into actual contact with it. At the experiments last year, the wooden booms were unhinged and splintered under a much less violent shock than that of yesterday. But the steel booms employed, though somewhat bent, remained unbroken and in position, and the joints were quite uninjured. All that is necessary for perfect defense is that the booms should be made a little heavier.

At the third trial, June 13, the torpedo operators attacking the *Resistance* exploded 95 lbs. of gun cotton 20 ft. below the water and in contact with her double bottom. This amount of explosive represents the full charge of the old pattern 16-in. Whiteheads, but as the hulk was, for prudential reasons, moored close to a mud-bank, and as the water was consequently much too shallow to allow of a locomotive torpedo being set to run at the required depth, a fixed charge was lashed fore and aft against the bottom plating of the ship and electrically exploded from No. 95 torpedo boat.

In previous experiments this year, the ironclad was attacked on the port side, which had been specially strengthened for the occasion, and the result, as we have pointed out, was a victory for the defense. This time the starboard side was selected for attack, in order that a comparison might be instituted with the effects produced under different conditions by a similar experiment. Last year, in the latter case, the double bottom was filled with coal; this year, the double bottom, which is about 2½ ft. deep, was kept empty and the torpedo placed in immediate contact with it, in such a manner that, being overhung by the contour of the hull, the ship would feel the full force of the upward, as well as the lateral, energy of the charge. The importance of the experiment was obvious, for, although it had been ascertained that torpedo nets were capable of protecting a battle-ship from the bursts of the heaviest locomotive and outrigger charges, it might happen, of course, that the nets would be rent or displaced by shell fire or swept away by a grazing ram or even attacked by a double torpedo, the second passing through the gashes made by the explosion of the first in any case.

It was of urgent necessity that the effect of a torpedo bursting in immediate contact with a ship's bottom should be practically and clearly determined. The charge was fired just before 5 o'clock, in the wake of the boilers, and it was soon perceived that something of a fatal character had taken place, from the appearance of coal dust sweeping up through the hold. The report had not the dull boom to which the spectators had become accustomed. Instead of this, the gun cotton exploded with a sharp, angry, whistling noise, while the manner in which the mud was churned up showed that the force of the rebound was terrific. The ship lifted bodily near the stern, after which it was seen to leisurely heel over to starboard some eight or ten degrees, and finally repose, though not until the tide fell, upon the mud. The old hulk had been mortally wounded at last. A complete knowledge of the disaster which has overtaken her will not be obtained until a careful investigation has been made of the hull in dock. But, from a hasty exploration which was conducted on board, it was evident that the shot had not only dislocated the inner plating of the double bottom, but had penetrated the bunker compartment, stored as it was with coal, that the water-tight doors and compartments had ceased to operate, and that water was flowing into the hull through a hundred crevices. To such an extent was this the case, that, though a strong working party was at hand, ready for any emergency, it was deemed useless to attempt to free the ship of water until her gashes had been temporarily closed from outside. When this has been done, she will be pumped out and brought into dock for careful examination. From what has been said, it will be seen that, while the explosion of 95 lbs. of gun cotton in actual contact, last November, simply crippled the *Resistance*, the explosion of a like charge, at the same spot and under approximately the same conditions, has in this instance, not simply disabled, but really sunk the ship.

Manufactures.

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

(Concluded from page 331.)

CHAPTER V.

THE RUNNING GEAR.

TRUCKS.

When trucks were first used in this country, it was considered very essential that their axles should be as near together as possible, and from figs. 12 to 22 (pages 43–46, January number) it will be seen that the trucks of all the early engines built at the Rogers Works had their wheels as close to each other as they could be placed. With outside cylinders this could be done without difficulty so long as the cylinders were inclined, but owing to the rolling motion which was produced by cylinders, with a steep inclination and also other inconveniences, the tendency was to lower the cylinders, and, excepting with large driving-wheels, this made it necessary to spread the truck-wheels farther apart. Finally, the cylinders were brought down horizontal, and it was then found that there was really no disadvantage in placing the wheels the required distance apart, but rather the reverse.

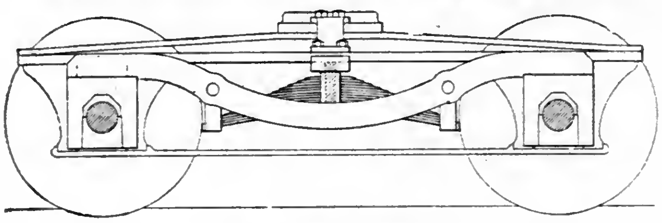


Fig. 204.—1850.

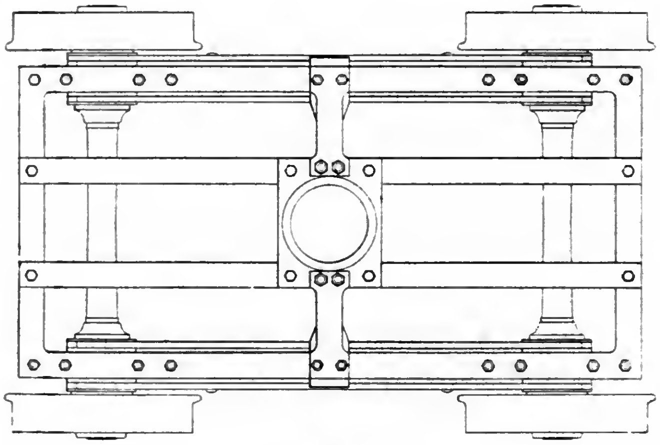


Fig. 205.

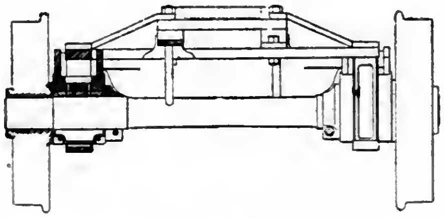


Fig. 206.

Excepting as they are shown in the small engravings of the engines, no drawings of the early trucks which were made at the Rogers Works have survived to the present time.

In 1850, Mr. Rogers designed the truck shown by figs. 204, 205 and 206. This had a rectangular wrought-iron frame with either cast or wrought-iron pedestals bolted to it, and with a pair of bent equalizing levers on each side and a spring between the wheels, as shown. The center-plate was carried on a system of bracing, clearly shown in the engravings. This form of truck has been built continuously ever since it was first introduced, with very little change, and has been adopted by other locomotive builders substantially as it was designed by Mr. Rogers, and probably is more extensively used, and has given greater satisfaction than any other form of locomotive truck that has ever been made. It is still the standard locomotive truck on many railroads.

Figs. 207, 208 and 209 represent a truck introduced in 1852. This had journal bearings both inside and outside of the wheels. It was used for fast passenger engines, and is shown in fig. 23 (page 46). It was first made with a center bearing, but later the Bissell arrangement, which is shown in the engravings, was combined with it.

In 1857, Mr. Bissell patented the truck which ever since has been known by his name. His first patent was for a four-wheeled truck, shown by figs. 210, 211 and 212. The frame of this truck was extended backward, and instead of turning around a center-pin between the two axles, the pin *C* was placed some distance behind the rear axle, and the truck turned or vibrated around it. The engine rested on a pair of V-shaped inclined planes, midway between the two axles. One of these inclined planes is shown in section at *D* in fig. 212.

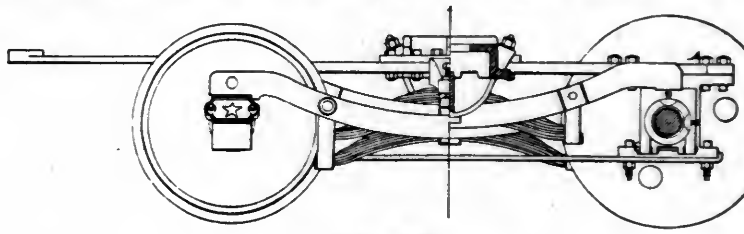


Fig. 207.

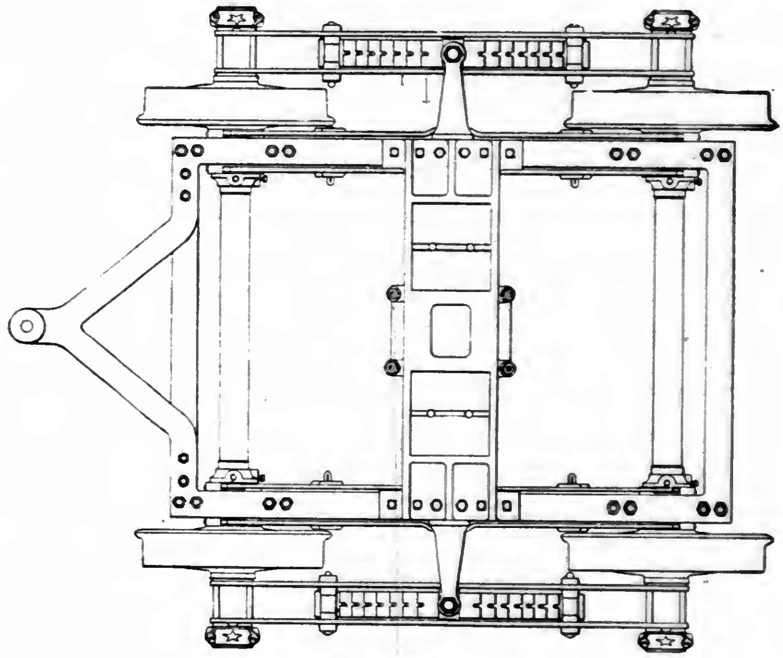


Fig. 208.

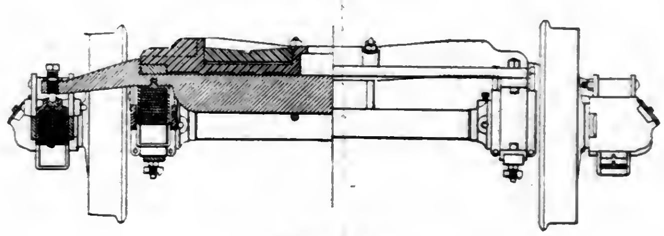


Fig. 209.

The inventor claimed that a truck of his plan adjusts itself to the curvature of the track better than one of the ordinary plan. Mr. Hudson was one of the first to recognize the value of Bissell's invention, and applied it to a locomotive in 1858. In the same year Bissell patented the single axle or "pony" locomotive engine of a truck or pilot fitted with pendant links to allow of lateral motion to the engine." Smith's invention consisted in the substitution of swing links for the inclined planes in Bissell's truck. Smith's truck is shown in figs. 216, 217 and 218. The engine rested on a bolster, *B*, which was

Fig. 210.

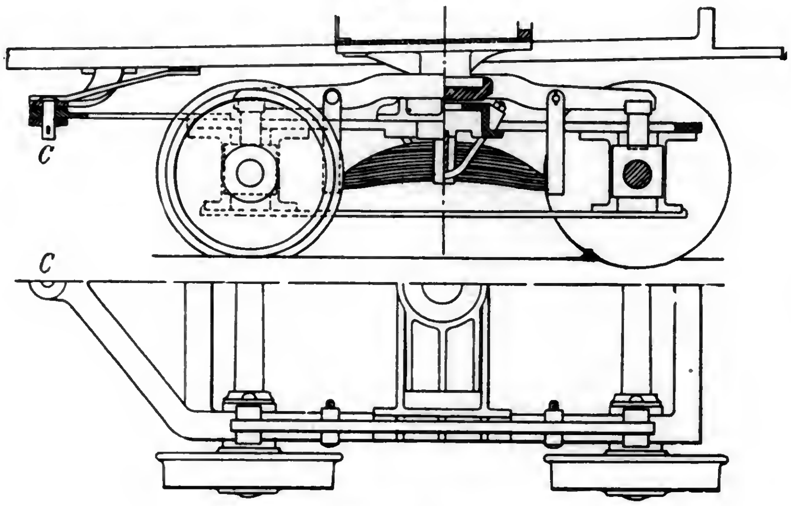


Fig. 211.

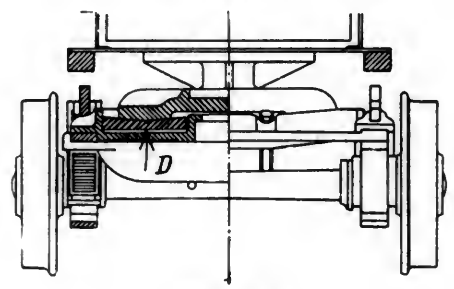


Fig. 212.

Fig. 213.

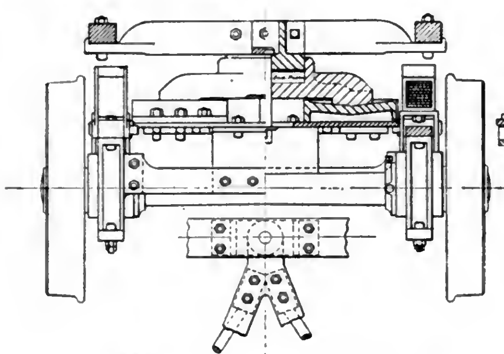
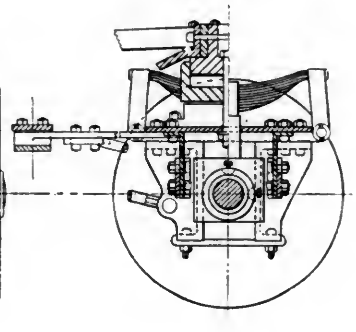


Fig. 215.



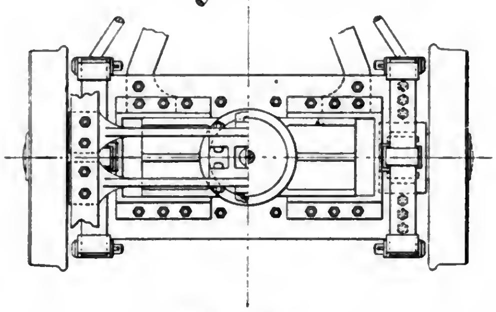


Fig. 214.

truck as it is often called. This was constructed on substantially the same principle as his four-wheeled truck, and is represented in figs. 213, 214 and 215 In the engraving, fig. 214, to save room, the extension of the frame, which is attached to the center-pin, is represented as being broken. This truck was applied to some Mogul engines at the Rogers Works in 1863.

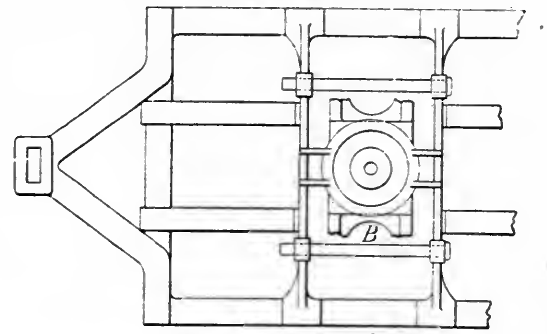
In 1862, Mr. Alba F. Smith patented "the employment in a suspended from the truck by swing-links *L L*, figs. 216, 217 and 218. From these it received the name of the swing-motion truck. It was first applied to a locomotive at the Rogers Works in 1865.

In 1864, Mr. Hudson took out another patent for an improvement in lateral moving trucks, which is shown in figs. 219, 220 and 221. Instead of pivoting the trucks to a fixed

point behind the axles at *A*, as Bissell did, Mr. Hudson used a long link or "radius bar," *B B*, which was pivoted at its front end *C* to a pair of lugs attached to the center-pin plate of the engine. The back end of the radius bar was allowed some lateral motion, but was confined within certain limits by a sort of guide shown at *D*. This arrangement, Mr. Hudson claimed, permitted the truck to adjust itself more perfectly to curves of different radii than was possible without the use of it was pointed out that it had equalizing levers, which extended from the driving-axle to the center of the truck on each side of the engine, with springs in the center of the levers. Although this arrangement did not give satisfaction at that time, it had the germ of an invention which Mr. Hudson afterward applied very extensively.

In 1864, he patented the arrangement, shown by figs. 222, 223 and 224, of an equalizing lever between the two-wheeled

Fig. 216.



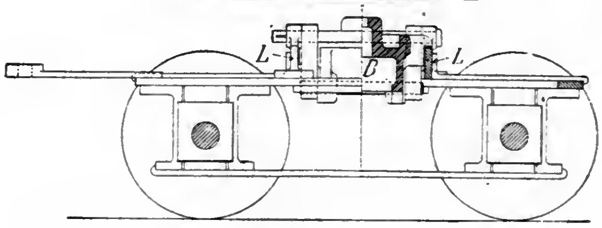


Fig. 217.

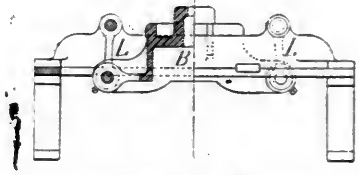


Fig. 218.

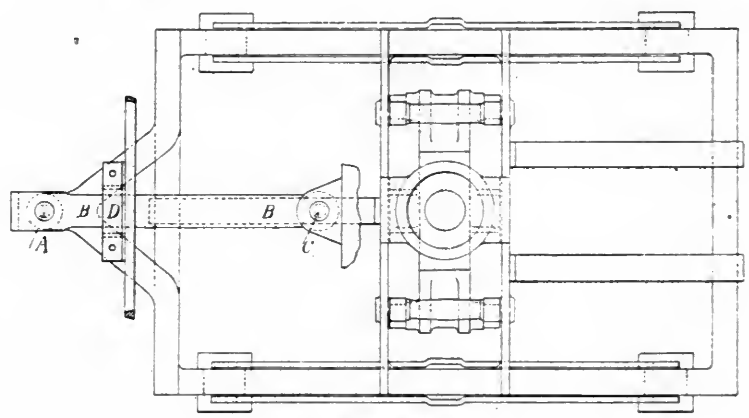


Fig. 219.

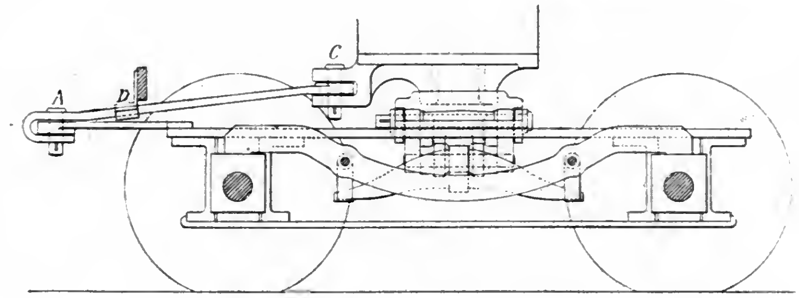


Fig. 220.

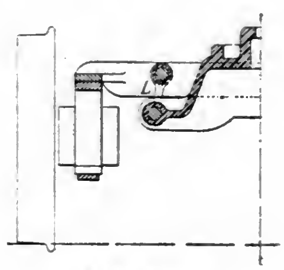


Fig. 221.

the radius bar. The arrangement was used with both Bissell's and Smith's lateral motion mechanism.

The most important results accomplished by Bissell's invention were due to the adoption of his lateral moving single axle or "pony" truck, as it is called, which was pivoted behind the axle. The first engine of the "Mogul" type, fig. 26 (page 46), which was built at the Rogers Works, had a two-wheeled Bissell truck with the inclined planes for producing the lateral motion. It was completed in 1863. Afterward, the swing-links patented by Mr. Smith were used.

In the description of the engine illustrated by fig. 17 (page 45), truck and the front driving-wheels, whereby both the truck and driving-wheels maintain their proper portion of weight and accommodate themselves to the vertical, as well as to the lateral, motion required to enable the engine to pass over uneven tracks and around curves with ease as well as with safety. In the arrangement referred to the driving-wheels *E* and *F* each have the usual springs *e* and *f* connected together by an equalizing lever *I*, with a fulcrum at *i*. The driving-wheels *G* have springs *g*. The front strap or hangers *n* of these springs are connected to a cross-beam, *J* (shown clearly in fig. 223). A central equalizing lever, *K*, bears on the middle of the

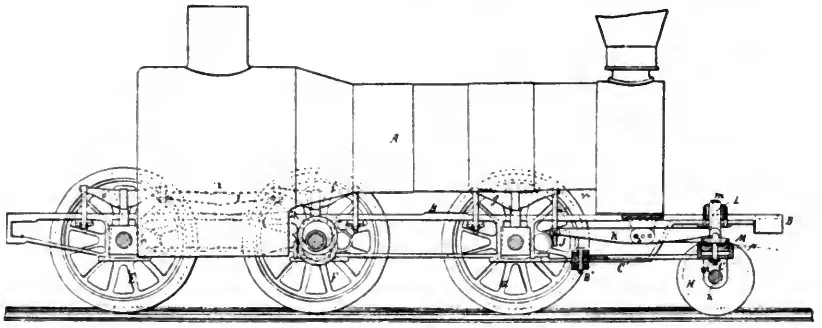


Fig. 222.

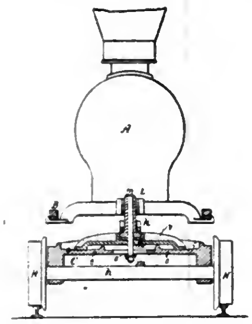


Fig. 224.

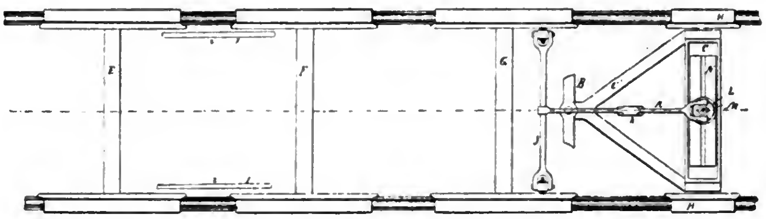


Fig. 223.

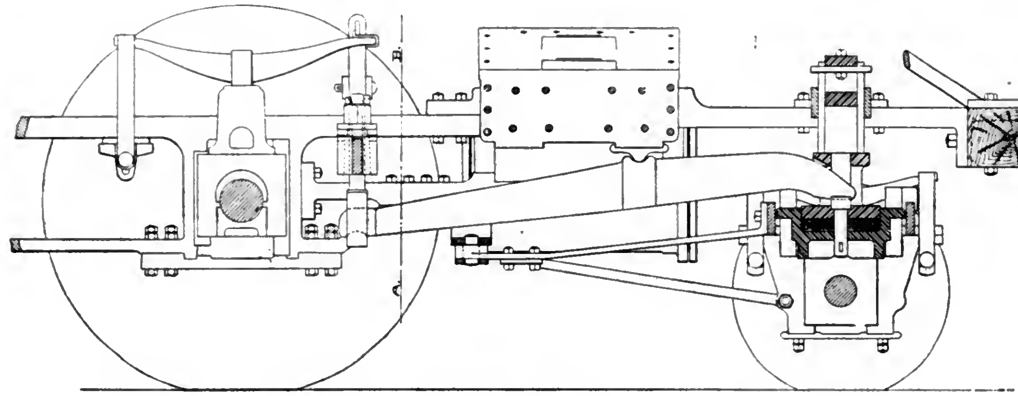


Fig. 225.

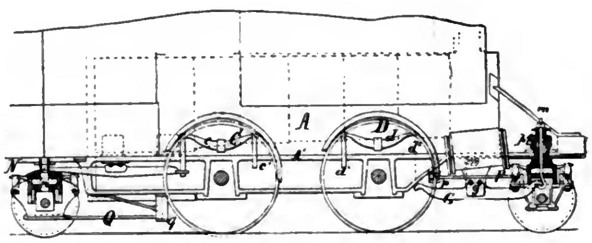


Fig. 228.

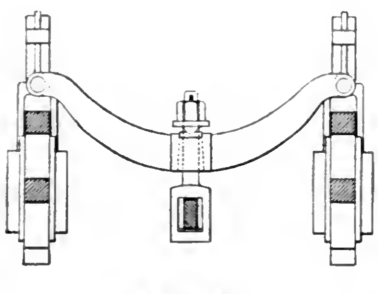


Fig. 226.

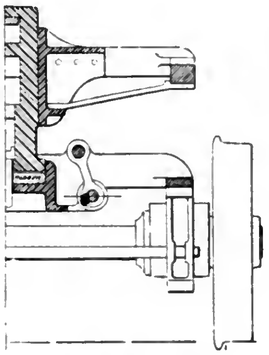


Fig. 227.

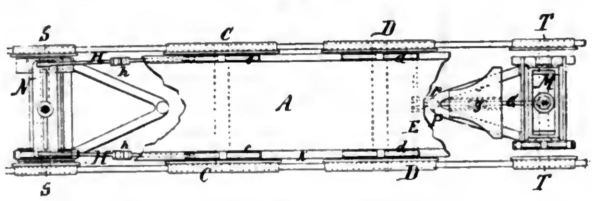


Fig. 229.

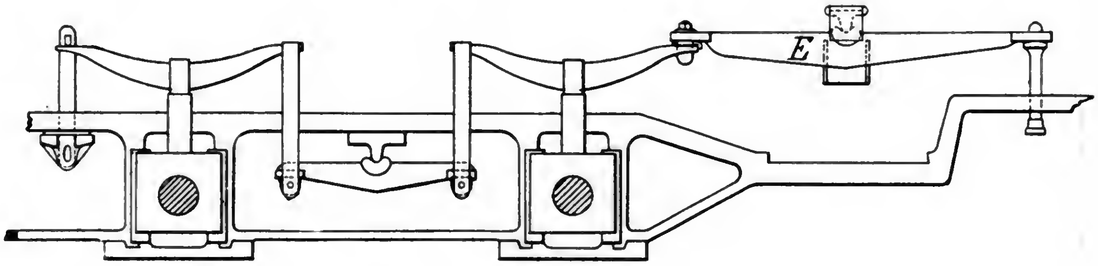


Fig. 230.

cross-beam J. It has a fulcrum at k, and its front end rests on the bolster or swing-beam N of the truck. The effect of this arrangement is that any weight borne by the driving-wheels is transmitted to the truck and *vice versa*. In his patent specification Mr. Hudson said:

"If tracks could be made perfectly uniform and regular and be maintained in that condition, my invention would be of little importance; but in practice irregularities more or less serious occur at nearly every joint or junction of the ends of the rails, and at certain points in the track, as in passing switches and across tracks, and especially in passing over small obstacles or defects in the road, the inequality in the load which is thrown upon the several wheels becomes immense; unless, in addition to the use of the springs, provision is made, by introducing equalizing levers in some manner, to induce a unity of action between each pair of wheels and some other pair. The three pairs of drivers, E, F and G, fig. 222, have been connected together by equalizing levers: but I have never known the two pairs E F to be connected into one system, and the forward drivers G to be connected to the truck-wheels, so as to form another and independent system, previous to my invention.

"My invention practically supports the forward portion of the structure at the point k, and the rear portion of the structure on the two points i i, opposite the sides of the fire-box; thus making a triangle on which the structure is carried with a certainty of holding each wheel with sufficient force upon the track, and yielding easily and safely to every ordinary inequality."

Figs. 222, 223, and 224 are copied from the drawing of the patent specification. In these drawings a truck, with Bissell's inclined planes c c, is represented. Figs. 225, 226 and 227 show the arrangement used by Mr. Hudson in 1865 for "Mogul" locomotives. In this truck Smith's swing-links were substituted instead of Bissell's inclined planes.

In 1867, Mr. Hudson patented his double-end truck locomotive, to which reference was made in a previous chapter. Figs. 228 and 229 are copied from his patent specification. In this engine the Bissell truck at each end was connected with the springs of the driving-wheels adjoining. The truck of what is ordinarily the front of the engine was connected to the driving-wheel springs by a single equalizing lever in the manner already described. At the opposite end of the engine there were two equalizing levers, one on each side of the fire-box, as shown in the engraving.

In 1872, Mr. Hudson patented another form of double-end truck locomotive. This had a four-wheeled swing-motion truck behind the fire-box, and a "pony" truck in front of the cylinders. Fig. 230 shows the arrangement of the driving-wheel springs and the way that they were connected with the "pony" truck by the equalizing levers E. The driving-wheel springs were not connected with the four-wheeled truck.

As was stated in a previous chapter, in 1872, Mr. Hudson took out a number of patents covering different forms of truck locomotives to which his method of equalizing the truck with the driving-wheels was applied.

(*Concluded.*)

Manufacturing Notes.

THE Rhode Island Locomotive Works in Providence, are to build 45 locomotives for the new elevated lines in Brooklyn.

THE Sharon Steel Casting Company, at Sharon, Pa., has just completed an extensive plant for making steel castings of all sizes.

ANOTHER large foundry room is to be added to the now large foundries of the Bass Foundry & Machine Works, at Fort Wayne, Ind.

THE Portland Company, in Portland, Me., has an order for 20 locomotives for the Boston & Maine Railroad. These works now employ about 350 men.

THE Dickson Manufacturing Company, at Scranton, Pa., is building 9 locomotives for the St. Paul & Duluth Railroad, and has a number of other orders on hand.

THE Pond Engineering Company, in St. Louis, has recently taken orders for a number of boilers, ranging from 50 to 100 H. P. These orders come from Kansas, Nebraska, Missouri, Arkansas and Texas.

THE Harlan & Hollingsworth Company at Wilmington, Del., on June 16, launched the steamer *Parthian*, 246 ft. long, 38 ft. beam and 26 ft. depth of hold. The *Parthian* is intended to run between Boston and Philadelphia.

AT the Columbian Iron Works at Locust Point, Baltimore, the keels have been laid for two new steel ferry boats for the Staten Island Rapid Transit Company. The steel for the new gunboat No. 2, for the U. S. Navy, is now being received at these works.

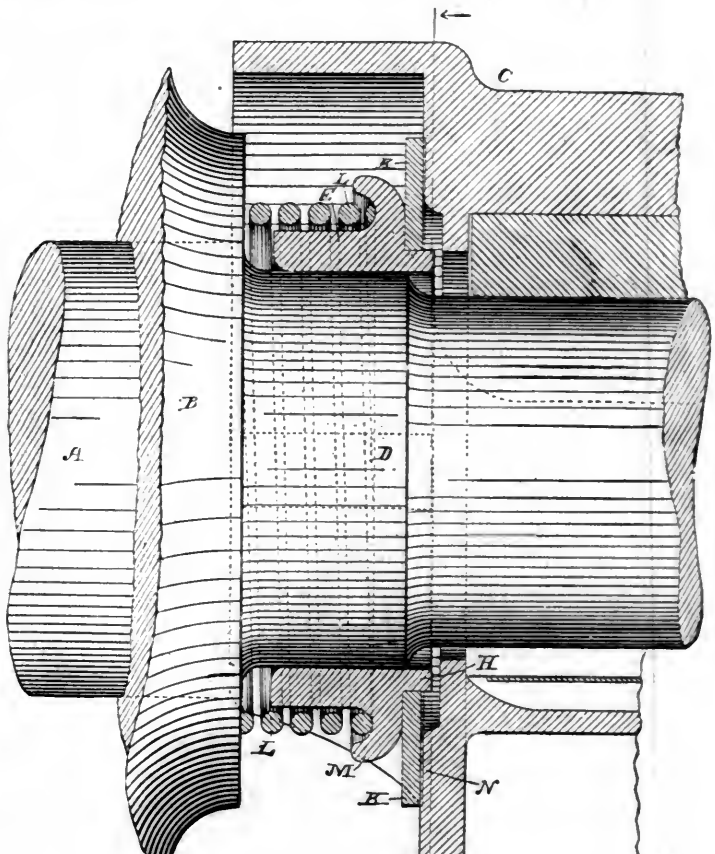
THE Pennsylvania Steel Company is about to build two blast furnaces of 200 tons daily capacity, at Sparrow Point, near Baltimore, Md., where it recently purchased a tract of 100 acres of land. It is said that a rolling mill will also be built, and other portions of the works, now at Steelton, will be hereafter removed to the new location. The company recently ordered 16 boilers of 240 H. P. each, from the Babcock & Wilcox Company, for the new furnaces.

THE Old Colony Railroad shops in Boston are building three new passenger engines with 17 × 24 in. cylinders, from the designs of Mr. James V. Lauder, the Superintendent of Motive Power. Engines of this class now in use take trains of 14 and 15 cars at high speed. The steamboat train on this road now makes the run of 51 miles between Boston and Fall River without stopping, the engine being provided with a special tender carrying 3,500 gallons of water.

Dust Guard for Car Axle-Boxes.

THE engraving shows a form of dust-guard which has been patented by Mr. W. S. G. Baker, President of the Baltimore Car Wheel Company, which he describes as follows:

"A indicates a car-axle, B a section of a car-wheel, and C a car-axle box, which parts may be of any ordinary construction. Around that part D of the axle known as the "dust-collar" I place a metallic sleeve' E, preferably formed with a feather, on its inner side, which fits in a longitudinal groove or keyway in the dust-collar of the axle, so that the sleeve, while keyed to the axle so as to revolve with it, is free to move longitudinally upon it.



BAKER'S DUST GUARD FOR CAR AXLE-BOXES.

The face of the sleeve next to the axle-box is provided with an annular projection, having lugs for the purpose of securing a suitable washer, K, which may be of vulcanized fiber or other suitable material, in place, and causing it to revolve with the axle and sleeve.

L indicates a coiled spring around the outside of the sleeve E, bearing at one end upon a ledge or projection, M, which is a part of the sleeve, and at the other end against the car-wheel. This spring forms a cushion between the sleeve E and the car-wheel, and causes the sleeve to press against the washer C and cause it to bear upon the end of the axle-box, so as to make a tight joint and exclude dust from the box and prevent the oil from escaping.

The patent is dated April 19, 1887, and numbered 361,255.

Special Tools for Railroad Repair Shops.

(*Continued from page 280.*)

THE late W. W. Evans, the eminent engineer, wrote, not long before his death: "Portable tools are very useful in any railroad machine shop, and will be very extensively used. I can recollect the time when I would have given a good deal if I had known where I could get such tools. Now, I am retired from active service in railroad management, having been 47 years in harness." Among this class of tools is Greenwood's universal planer chuck, shown in figs. 17 and 18.

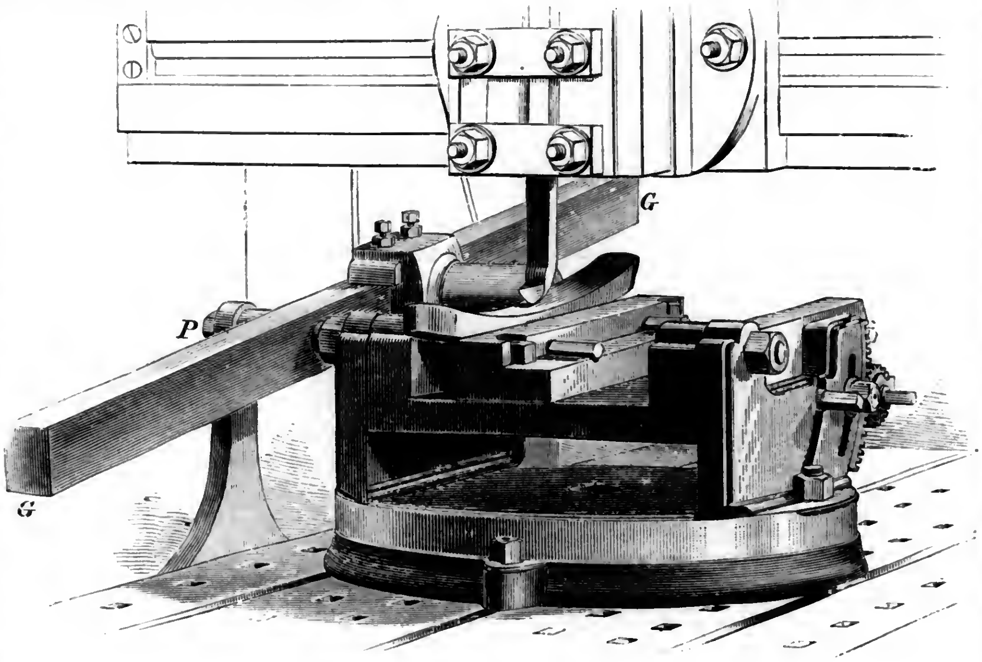


Fig. 17.

There are various tools for the same purpose. But these have two serious drawbacks: 1. There is great inconvenience in setting to radii differing considerably, say from 4 ft. to 10 ft., and it is next to impossible to set to a radius of 100 or 1,000 ft. 2. In these the feed must be in a vertical direction, which is very inconvenient for a common planer having the attachment, and the extent of such vertical feed is very small.

But in the new tool the cross-feed of the planer is perfectly applicable; also, any possible radius is at command, and as easily set up as to put a tool into the tool-holder. The tool, it is claimed, is remarkable for possessing these qualities in high degree, and the chuck is simple as it is remarkable. To get a better notion of this tool in a practical sense, imagine a concave surface (cylindric) dressed or planed in a block 1 or 2 ft. wide by 4 ft. long to a radius of 500 ft. Then imagine a convex surface of equal dimensions planed in a second block to an exact fit. The radius might have been 50, 100 or 1,000 ft. just as easily. No pieces are required to be taken out and others substituted to make any of the changes of radius, the chuck being complete in itself, as well as simple.

Though the leading feature of this chuck is its facility and capacity for planing circular curves of large radius, it still possesses other adaptations, including all those of the best planer chucks. For this reason it is styled the universal planer chuck.

The various functions of the chuck will be more clearly understood after describing its parts. The perspective view in fig. 17 gives a good idea of its external appearance, it being shown complete with the guide bar, its bracket and pivot and the arc or quadrant by which the guide bar is set to plane any particular circle. But without these the chuck as shown in fig. 17 will answer all the purposes of the best chucks. It will revolve horizontally to any angle of cut, and can be set by the dial shown, graduated upon the edge of its base. By this movement the chuck and piece can be turned end for end in planing straight work. The vise for holding the work is like a stout trough without ends, in which slides the movable jaw by the screw. This screw has a head at the back side of the chuck, so that in the grip for holding the work, the screw draws instead of pushes. This throws the strain off from the greater part of the bottom of the vise, and springs it much less than otherwise would be unavoidable.

The vise is pivoted to two supports, one on each side, and at the left-hand end in the cuts. These supports project up from the chuck body, within which the vise is placed. Room is allowed at the bottom of the second piece to allow the vise to rise and fall at the right-hand end. It is made to rise and fall in dressing circular surfaces by the crosshead projecting at the back side of the

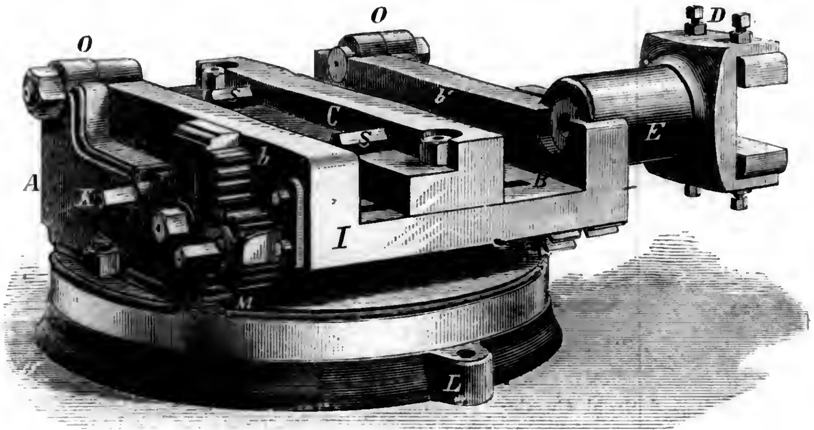


Fig. 18.

GREENWOOD'S UNIVERSAL PLANER CHUCK.

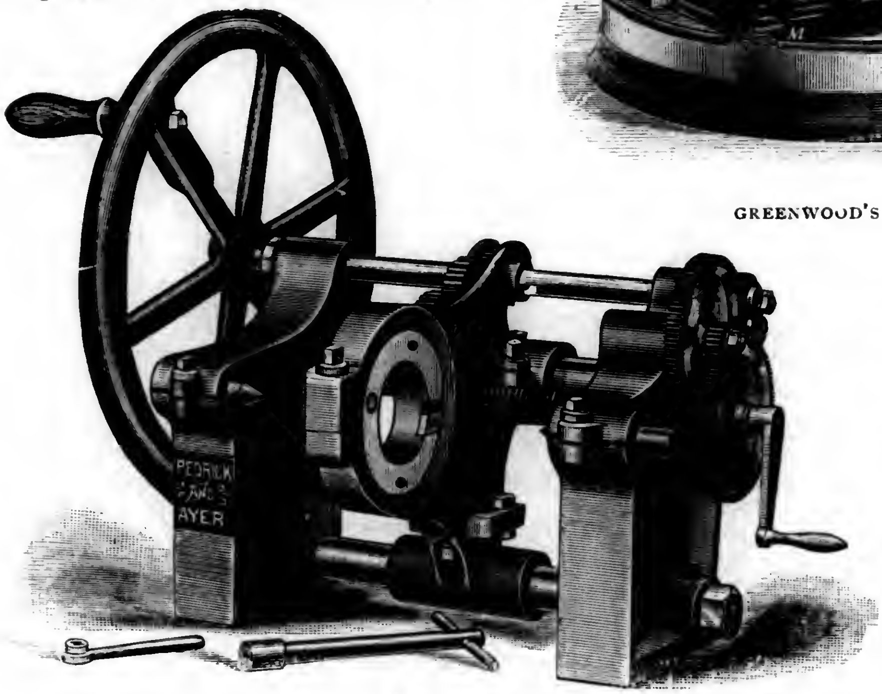


Fig. 19.

PATENT PORTABLE WRIST-PIN MACHINE.

chuck, and sliding upon the guide bar—when the latter is elevated at the end toward the right, a concave surface is planed, and when depressed a convex surface is cut. To change the degree of convexity or concavity the inclination of the guide-bar is to be changed, it being horizontal for planing straight. The guide-bar is fixed at one point by a pivot about which it swings in being raised or lowered at one end. This pivot is supported by a bracket fastened firmly to the frame of the planer below the platen.

The movement by which the circle arc is secured in dressing work is indicated thus: Suppose a piece of work clamped in the vise, and the guide-bar set at an inclination. Then as the platen of the planer is moved forward and back, as in planing, the base of chuck is borne upon it, also the vise and cross-head. But the latter, in sliding upon the stationary inclined guide-bar, must slide on an incline. This makes one end of the vise of chuck rise and fall, the other end being held at a constant height above the platen by the vise pivots. This gives a revolving or swinging motion of vise above a horizontal axis. The cutting tool now being brought to bear upon the piece of work cuts it to the circular arc. The tool can always be so placed as to give a mathematically correct circle.

The vise may be fastened in a horizontal position by a conical pin. The screw in the curved slot in the front side of chuck also aids to clamp the chuck in a horizontal position. This also will clamp the vise at any inclination. When thus clamped at an inclination, a wedge may be planed in the chuck or a key and gib for a connecting rod, etc. When the jaw of the chuck is clamped in any position, as just explained, of course the guide-bar is not required. To use the chuck free from the guide-bar, it may be turned end for end. When the crosshead is freed from the guide-bar by being brought around upon the front side of the chuck the crosshead may be slipped off the end of guide-bar and from the pin on which it works.

In thus turning the chuck around, the trough-shaped piece which carries the vise slides around upon the base piece of the chuck, which latter is bolted fast to the platen of the planer.

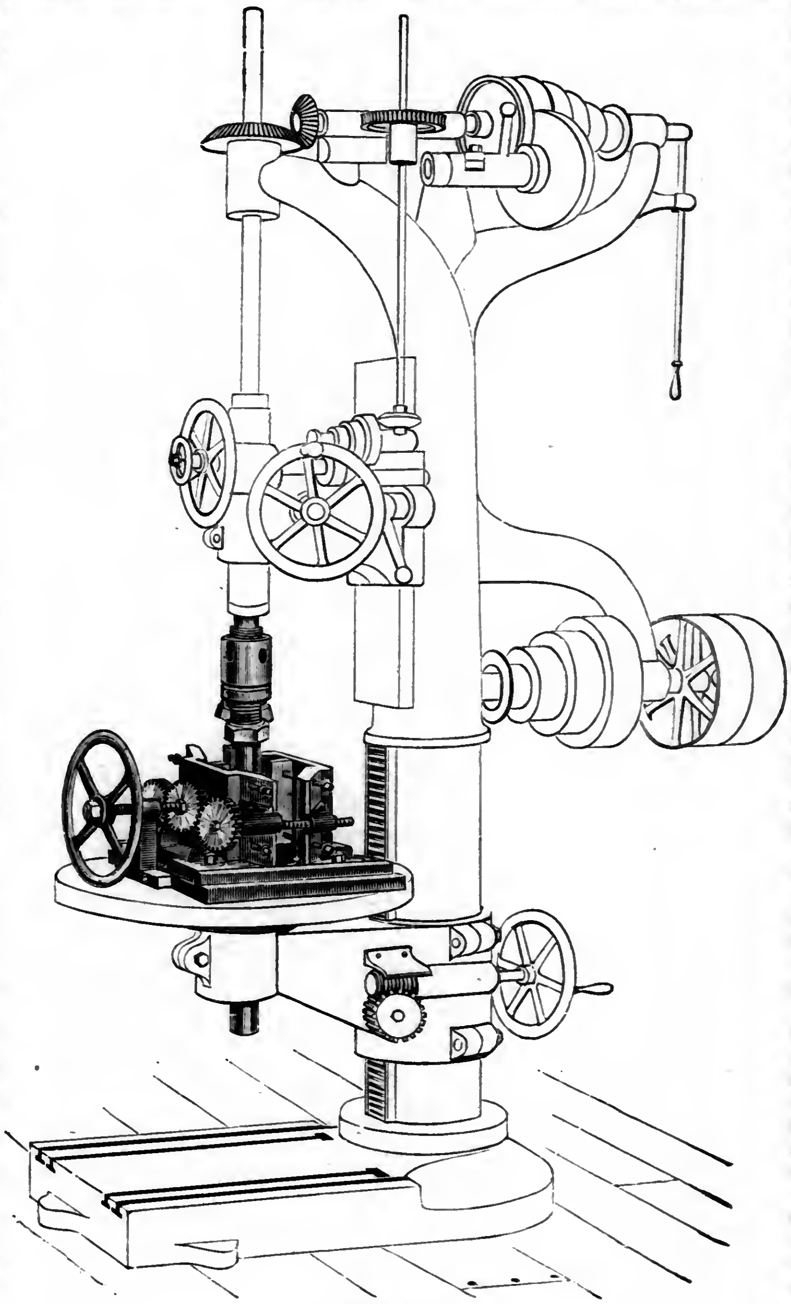


Fig. 20.

OTTO'S CAR-BOX BORING ATTACHMENT.

The jaw of the chuck has a graduated arc by which the inclination for any wedge or key is easily given. Also the guide-bar has a graduated arc for setting it to any given circle arc. A table is prepared for use in setting the bar at once and correctly. A segmental rack and pinion is applied to the jaw of chuck in such a way that the weight of the jaw is easily lifted by applying a wrench.

Thus we have in this universal planer chuck, the ordinary chuck, a chuck for planing tapers and keys, and the extraordinary novelty of the circle planer for long radii, so that the possession of this chuck enables the workman to do all the various kinds of work described, with the cross-feed of the common planer found in every machine shop, and without other or additional appliances. The chuck is comprised in three principal parts—the bottom plate L, by which it is fastened to the planer table, the vise C, by which the work is held, and a guide-bar, G, held by a bracket on the planer-bed. With these parts it is possible to produce a great range and variety of work.

The truing up of a crosshead pin or wrist-pin by hand, or with bent tools in a lathe is a very expensive job. The work performed by the patent portable wrist-pin machine shown in fig. 19 is very important, reducing the cost of this work very materially. In the planning of this machine, special attention has been directed toward securing facility of operation in the limited space available, and is readily manipulated and handled by the ordinary workman. It consists of two side castings or housings, held together by two parallel rods, ground true. These rods serve as guides, on which the turning device slides. Between the two guide-rods, a screw is placed, as near as possible to the work, and this screw being turned by gearing on the end of the crank-shaft, becomes an automatic feed, which will operate in either direction; or, for convenience in finishing out the fillets at either end of the wrist-pin, this feed can be thrown out, and the device worked by hand.

The sliding arrangement which carries the annular cutter-head or tool-holder is composed of two parts, held firmly together by four steel collar-bolts, the parting line being exactly in line with the guide-rod and feed-screw, and all together are on the center line of the machine.

The cutter-head or tool-holder is of steel, and its division allows it to be adjusted around the wrist-pin to be turned. Gear-teeth, cut out of a portion of its circumference, engage with others, operated by the crank-shaft.

In the housings, centers are placed to hold the crosshead to be operated on. These centers are in line with the main guide-rod, and exactly central to the tool holder.

The tools are inserted in the sides of the tool-holder, and are held in place by screws fitted into holes, countersunk for manipulation by a socket-wrench, and can be readily taken out to grind.

Special care should be taken in laying out the crossheads to be operated on. See that center marks of sufficient depth are made in the end opposite the intended center of the wrist-pin; then place the cutter-head or tool-holder around the wrist-pin, with tools in, set back. Place the crosshead in the machine, on the centers; adjust the sliding frame on the guide-rods, and the work and machine are ready.

These machines are also built for stationary use in shops; and those of the stationary type, being driven by power, are adapted to a great range of work. The machine shown in the accompanying cut is of a size intended for general use in locomotive shops, either on new work, or for truing oval or cut wrist-pins.

Otto's car-box boring attachment, shown in fig. 20, is a simple and cheap method of boring out brasses for car-axle journals. A chuck arranged to be fastened to the table of an ordinary drill press with automatic feed and quick return holds the brasses to be bored, and by simply turning the hand-wheel

they are brought together and firmly held in place, a double adjustable cutter boring two brasses at a time. The brasses being less than a half circle, strips are placed between their faces. These strips or parallels are held separately by the set-screws and need not be disturbed when once adjusted for a certain size of box. When different sized boxes are to be bored, then other strips are required. The operation of setting the boxes is as simple as screwing up a vise. The two jaws are adjustable and move toward the center at one time, firmly holding the brasses against the strips. Recesses or sockets are formed in the octagon walls of the chuck, of sufficient width and depth to receive the largest sized brasses. In the rear half of the chuck is a horizontal channel which serves as a passage for chips or borings. Below the chuck is a bearing for the cutter-bar, which is kept free from chips and dirt by a rubber ring, giving a good opportunity to oil. This cutter-bar is fitted into the taper-hole in the end of the drill-press spindle. Through it a slot is made and two cutters with ends rounded are made to form a hinge or pivot for each other. The end that does the cutting is shaped so that a good cutting edge is made when the cutters are set close to the bar for a small hole or extended for a large one. They are designed to bore all sizes of car-axle brasses with one set of cutters. The ends of the cutters are thickened to have a grinding or sharpening surface and are sharpened by grinding on the face of them. They are extended or contracted by a nut, at top and bottom of cutters, which admits of very fine adjustment. This device can be very quickly put in place and at work, and when once adjusted, can be operated by unskilled labor. By having ring-gauges on the bar hung up over the cutters, they can be often tried and the cutters adjusted to bore standard sizes.

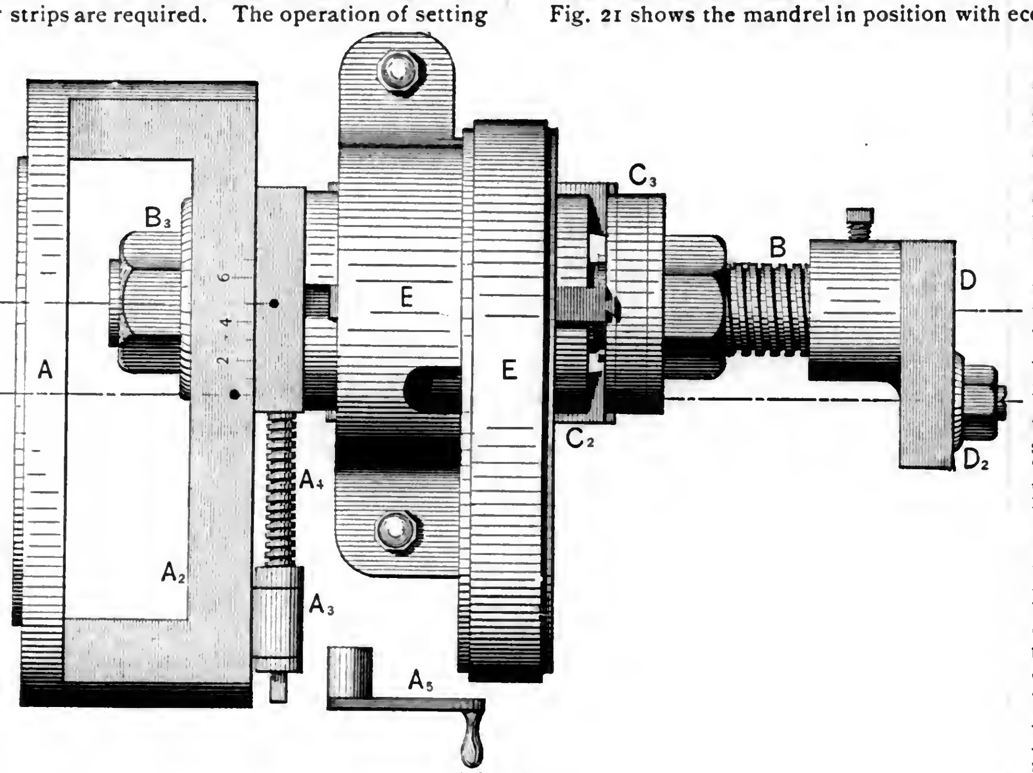


Fig. 21.

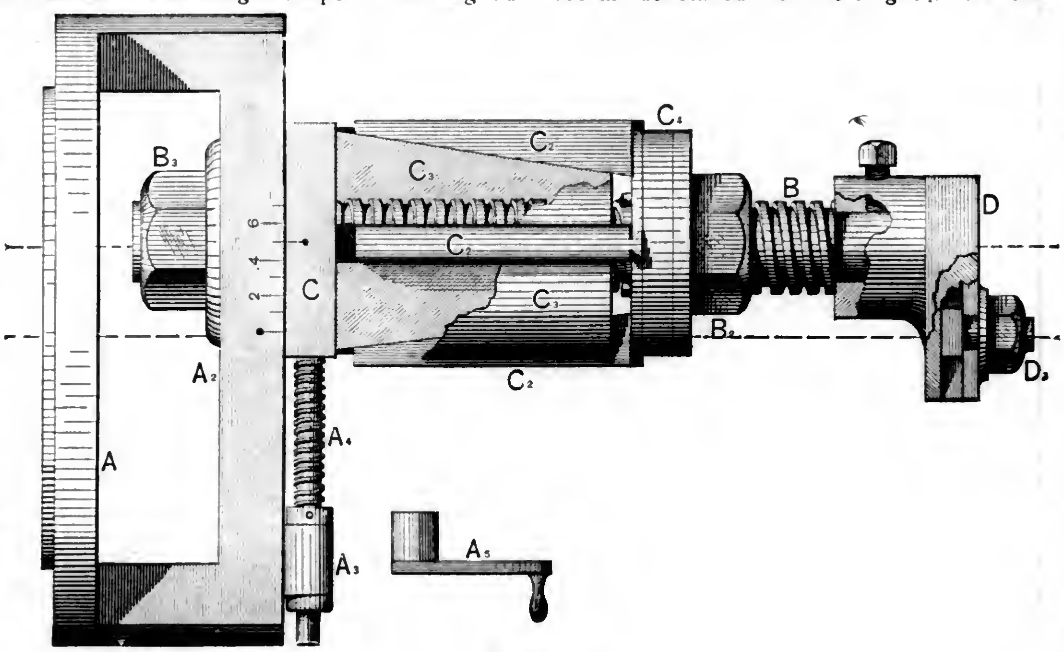


Fig. 22.
HODGSON'S ECCENTRIC MANDREL.

Figures 21 and 22 illustrate Hodgson's eccentric mandrel; designed for quickly and cheaply turning up locomotive eccentrics and other eccentric work of a similar kind; it has been used successfully in the shops of the Baltimore & Ohio Railroad.

This machine consists of a face-place, A, bolted directly on the face-plate of the lathe, an expanding mandrel, working in a slide, and a center, D_2, sliding in a direction opposite to that in which the mandrel is moved. This center takes a bearing on the dead center of the lathe.

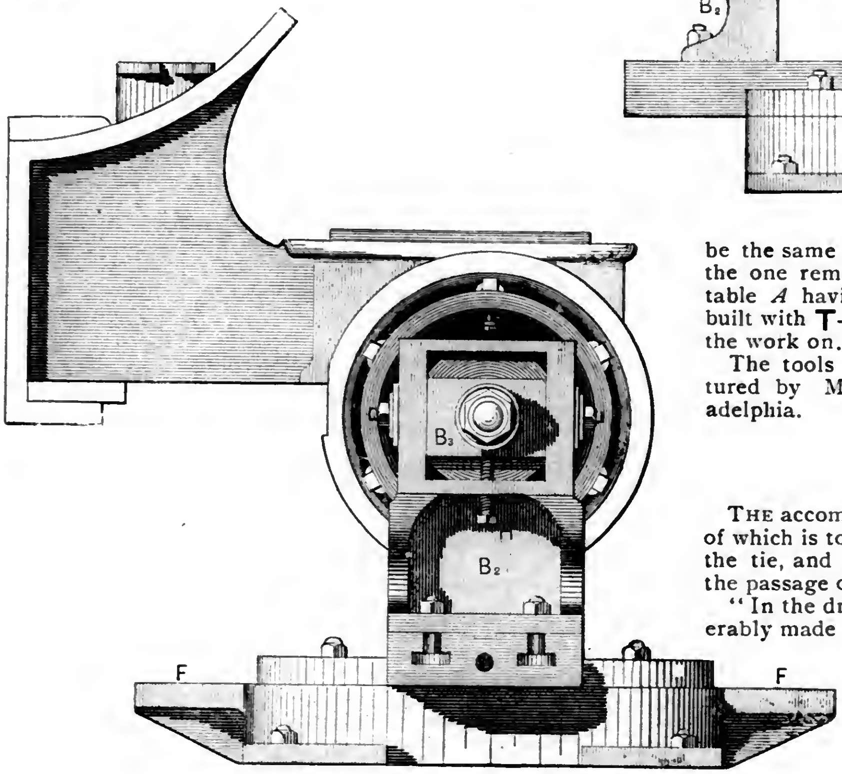
Fig. 21 shows the mandrel in position with eccentric E ready for turning. The mandrel is set by the gauge on the bar A_2, and, as shown in cut, is ready to turn an eccentric with a throw of five inches.

Fig. 22 shows the details of the construction. The bar A_2 has a slot in which the block C and the mandrel C_3 slide in and out. This block is held in place by the nut B_3. When the nut B_3 on the screw B is slacked up, the mandrel C_3 can be moved to and from the center by putting the handle A_5 on the screw A_4. A scale is marked off on A_2, the divisions being half-inches instead of inches, so that the throw of the eccentric is laid off from the drawing directly, without the liability to mistakes. The mandrel carries four wedges, C_2, which work in grooves with inclined bottoms. These wedges are all dovetailed into the ring C_4. As this ring is run in or out, the wedges of course are moved in and out correspondingly. The nut B_2, working on the screw B, controls their motion. The block D is put on the head of the screw to carry the sliding center D_2, and thus support the mandrel at the outer end. The center is formed on an ordinary **T**-headed screw with a cup end. This block comes off when a piece of work is to be put in place.

The machine shown in figs. 23 and 24 is Hodgson's cylinder planing chuck, which is used for holding cylinders of all sizes during the operation of planing, and obviates the necessity for setting the cylinder more than once on the planer, the setting being practically automatic.

The chuck consists of a circular base, A, which is bolted to the table of the planer, and carries upon its top the revolving top A_2. This revolving top has a bed-plate, E, on which there

is one fixed head-stock, D, and a movable one, B_2, between which the cone chucks D D are placed on the spindle C. On these cone chucks the cylinders are held. The upper portion of the table A_2, together with the bed-plate E, revolves on a center fixed in A. The lugs F and C_2 have bolt holes and stops, so as to permit the table to be turned a quarter of a revolution, and accurately squared without trouble in the adjustment. When the cylinder is bored out, no further setting is necessary. The chuck, when put upon a planer, insures the cylinder casting being in line, and enables the cross-planing to be done by merely revolving the base. The spindle C is pivoted at B_4, the opposite end being carried to the block B_3. The head-stock B_2 slides in or out on the base E, as shown in fig. 24, in order to accommodate cylinders of different lengths.



HODGSON'S CYLINDER PLANING CHUCK.

Fig. 24.

The jaws D_2, on the chucks D, slide in and out on the cones to take cylinders of different diameters. They are held by short screws in slotted holes, as will be seen by the section at the right of fig. 23. Fig. 24 shows a cylinder in place, ready for planing the valve seat. By a proper arrangement of the tools, all the planing on the cylinder castings may be done without releasing the casting from the chuck, thus insuring the work being done in line and square with the box. The diameter of the spindles is about 3½ in., and the distance between the cones, as shown in the cut, a little more than 24 in. A greater distance than this may be obtained by taking off some of the washers shown at C_2, fig. 23, and in moving the head-stocks B_2 back. The center of the spindle is about 16 in. from the bed E.

The radius link planer attachment shown in fig. 25, is used in planing curves of any radius and perfectly parallel; it is shown as applied to the ordinary planing machine. In this attachment a pin projecting from a plate bolted to the table of the planer holds an upper table A upon which the work is fastened. Thus the work may be moved forward and backward, and to a greater or less distance from the center-pin, the amount of circular movement determining the radius of the circle to which the work is finished. From the corner of the table A, a wrist projects upwards and takes hold of a slide which is fastened at the required angle to the beam of the planer. When the slide stands parallel to the bed of the planer, the table A will move in a straight line. In proportion to the angle of the slide with the bed of the planer, the table A will be deflected from a straight line into a true curve of greater or less radius.

In setting the link or slide-blocks for planing, the links or blocks require to be moved as well as the radius arm, and it is best to set the ends of work in line with bed at equal distance from center bolt. By shifting the link or block some, it will favor the radius arm and require less angle to do the work. The planing tool, if changed on the same piece of work, must

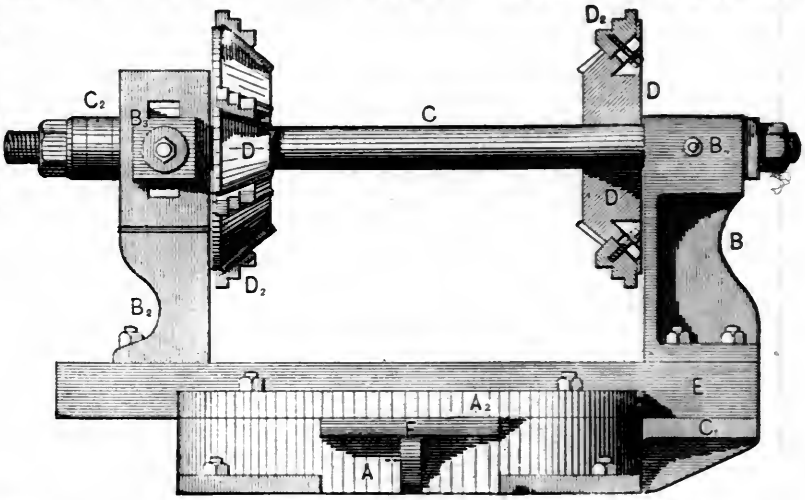


Fig. 23.

be the same distance from the back of the tool to the point as the one removed, or it will vary the radius. Instead of the table A having square holes, as shown in cut, they are now built with T-head slots, making it more convenient for bolting the work on.

The tools represented and described above are manufactured by Messrs. Pedrick & Ayer at their works in Philadelphia.

Railroad Rail-Spring.

THE accompanying illustrations show a rail-spring, the object of which is to interpose an elastic medium between the rail and the tie, and thus diminish the pounding and noise caused by the passage of trains. This device is described as follows:

"In the drawings, 10 represents a metallic plate that is preerably made of steel and shaped to elliptical form, the ends of

Fig. 25.

RADIUS LINK PLANER ATTACHMENT.

the plate being bent upward, as shown at 2. The upper and lower faces of the plate 10 are non-concentric, thus forming a plate that is thicker in the middle than at the ends.

"In the plate 10 are two slots or apertures, 11. These slots are preferably arranged upon distinct parallel lines and so

located that the distance between their approaching ends will be slightly less than the width of the base of the rail in connection with which the plate is to be employed, thus providing for the flattening of the plates.

"Plates constructed as described are placed upon the ties or sleepers 20, and the rail is placed upon the plates, as clearly shown in fig. 1, the parts being held to place by spikes 15, that are driven into the ties 20 through the apertures 11. The plates 10 are located in connection with each tie or in connection with so many of the ties as may be found to be desirable or necessary to properly support the weight of the passing trains.

Fig. 1.

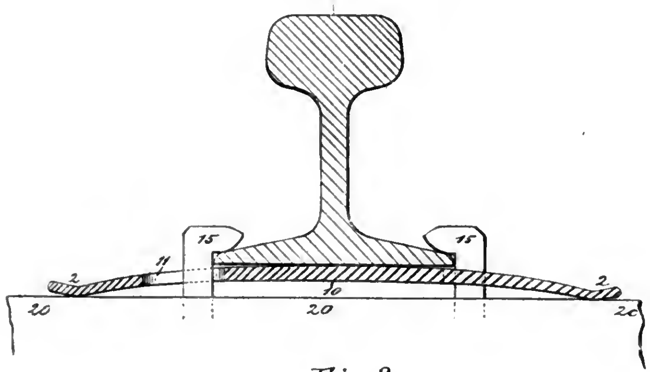
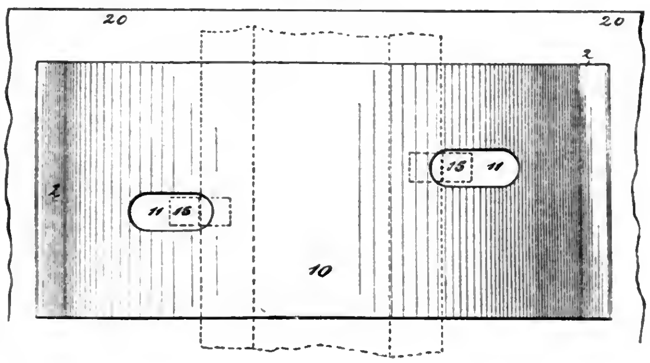


Fig. 2.



OLMSTEAD'S RAIL-SPRING.

"An inspection of fig. 1, which represents the plate as it appears when not subjected to the weight of a train, will show that the base of the rail only touches the plate at its center; but, as a train passes over the rail, the plate will be depressed, and in being so depressed will flatten, thereby presenting a broader bearing-surface for the base of the rail, and, consequently, the effect of the pressure upon the plate will decrease as the plate expands or flattens."

The patent, which is numbered 364,432, has been granted to Edward A. Olmstead, of New York.

New Hudson River Steamboat.

THE new steamboat *New York*, which has just been put on the Day Line between Albany and New York, on the first regular trip (July 18) made the run to West Point, 50 miles, at the rate of 20 miles an hour, and made several short stretches at the rate of 24 miles an hour.

The hull of the *New York* is of iron, and was built at Wilmington, Del., by the Harlan & Hollingsworth Company. The dimensions are: Length on water line, 301 ft.; length over all, 311 ft.; breadth of beam, molded, 40 ft.; breadth over guards, 74 ft.; depth, molded, 11 ft. 3 in.; draft of water, 6 ft.

The model of the sister steamer, *Albany*, designed by the late William Foulks of Greenpoint, was used in shaping the hull of the *New York*, it being changed only to suit the extra 15 ft. in length, 9 in. in depth, and the increased shear fore and aft. A noticeable change is that the wheels are placed aft of the center of length instead of forward, as on the *Albany*.

The engine, which was built by the W. & A. Fletcher Company at the North River Iron Works in New York, is a beam engine of the standard American pattern, with a cylinder 75 in. diameter and 12 ft. stroke, provided with Stevens' cut-off.

The use of a surface condenser, instead of a jet condenser, in this river steamer, is a departure from the usual practice, and this change was made to overcome the evil of using mixed salt and fresh water in the boilers.

Another important departure is the adoption of feathering wheels instead of the usual radial wheels, with fixed buckets or floats. These wheels are 30 ft. 2 in. diameter outside of buckets. There are 12 curved steel buckets to each wheel. Each bucket is 3 ft. 9 in. wide and 12 ft. 6 in. long, with an angle iron 3 × 5 in. on each end. The wheels are overhung or have a bearing outboard on the hull only. The feathering is done in the usual manner by means of driving and radius bars operated by a center placed eccentric to the shaft and held by the A-frame on the guard.

Feathering wheels have been constructed for sound or seagoing boats and for vessels whose load is changed materially from trip to trip; but it is novel, in this country at least, to apply them to a boat intended for smooth river service only, and whose load is practically constant. They were introduced in the *New York* for the purpose of gaining speed, and also of securing smoothness of motion and absence of jar.

Steam is supplied to the engine by three return flue boilers, each 9¼ ft. diameter of shell, 11 ft. width of front and 33 ft. long. These boilers are constructed for a working pressure of 50 pounds per square inch. Each boiler has a grate surface of 76 square feet or 228 square feet in all, and, with forced draught, can work up to 3,850 H. P.

There is also a donkey boiler for use when required. A large De Lamater duplex steam pump, with numerous pipes and valves arranged to ensure the safety of the vessel in case of danger by collision or fire, will be constantly running when the boat is in service. The boat is supplied with the Williamson steam steerer.

The cabin and upper works are of wood and of the same character as those of the other boats of the line.

The Mann System of Car Ventilation.

AT an inspection, made June 22 last, of the Mann system of ventilation, the New York Railroad Commissioners expressed their approval of the results shown.

This trial was made on the Mann boudoir car *Martha*, on the New York, New Haven & Hartford road, a run being made to Stamford (34 miles) and return. The ventilating apparatus consists of an external bonnet presented in each direction, with an internal hinged deflector so attached as to gather air whichever way the car is running, and a descending flue carrying the air down into a closet containing a shallow tank of water and a filter made of a body of excelsior in a box of wire netting, the fiber being kept wet by water dripping from ice in a crate above it. In summer time a large body of ice is also provided in an adjoining apartment of the closet through which the air is carried, after passing through the filter, and from thence it is distributed by a longitudinal flue occupying the inner angle between the wall and floor of the car on one side and extending from end to end. This horizontal flue is provided with outlet openings of small size near the supply end and increasing successively in area to the other end, in order to deliver a substantially uniform current of fresh air from end to end of the car. The horizontal air-flue also contains a system of pipes, which, as we understand, are used in winter time as hot-water pipes, being connected with the stove of the ordinary Baker heater, which is then placed in the air-purifying closet for the purpose of heating the fresh air as it passes through said closet and through the air flue. The air-flue is 14 × 3¾ in., giving, after deducting the space taken up by the heating pipes, a sectional area of 46.42 square inches. The weight of ice carried is about 350 lbs.

Professor W. E. Geyer and Mr. O. Knight, who acted as experts for the Mann Company, found on this trip that at a speed of 25 to 30 miles an hour the air passed through the air-flue at a velocity of 1,796.5 ft. a minute. At this rate 579 cubic feet of air per minute were supplied to the car, or enough to renew all the air in it in 5 minutes. As this car is intended to carry 26 persons, the supply is equal to 22 cubic feet per minute for each person. The experts further say:

"We found by the thermometer that the temperature of the air, where it emerged from the distributing flue into the car, was 62°, while the temperature of the air outside of the car was 82°.

"The vitiated air was constantly discharged from the car by exhaust outlets in the roof. The effect was that, while it was a hot and oppressive day and all the windows and doors of the car were kept shut, the atmosphere was fresh and comfortable during the whole period, and while a majority of the party

were smoking, the tobacco smoke and fumes were constantly carried off so that they were not in any manner oppressive or offensive. * * * *

"In two other coaches attached to the same train having their windows open, and the heat being consequently the same as that of the outside air, there was a sense of oppression which did not exist in the closed boudoir car, presumably due to the fact that the air supplied to this car through the filtering apparatus was cleansed from dust and impurities, and to the further fact that the air within was less humid by 2° than the outer air, as shown by the indications of a standard hygrometer."

Proceedings of Societies.

Institute of Electrical Engineers.

The last meeting of this Institute for the season was held in New York, June 28. Mr. Geo. W. Blodgett, of Boston, read a paper on Electric Lighting of Passenger Trains. A discussion followed by Messrs. R. W. Pope, Elias Ries, T. D. Lockwood, C. O. Mailloux, W. C. Bracken, J. M. Pendleton and Jos. Wetzler.

Before the paper of the evening was read, the House Fund Committee, through its Chairman, made a report of its progress. The subscription had increased to $4,500, almost entirely within the membership, with $1,000 additional virtually pledged by a gentleman greatly interested in the work of the Institute. A feature of the report was the committee's statement of the support and co-operation extended to the Institute by the Society of Civil Engineers. The President and Secretary of that Society had been appointed to confer with the House Fund Committee of the Institute upon plans for joint use of suitable premises. In the conference that was held Mr. Worthen and Mr. Bogart, in behalf of the Civil Engineers, expressed heartily their sense of the rapid growth of electrical engineering as a department of general engineering, and their desire to ally the Institute with their society for mutual advantage. Civil engineers were finding it necessary to increase their acquaintance with the applications of electricity, in order to meet the demands upon them of clients desiring to consult them upon questions of electric traction and transmission of power, while the constantly broadening field of the application of electricity calls for much general engineering knowledge on the part of electrical engineers. A location in common, an assembly room in common, a union of libraries, with a suitable provision of separate apartments for the use of each society would, it was thought, be of much mutual benefit. It was thought likely that the Society of Mechanical Engineers would come into such a scheme, and that ultimately all branches of engineering would have a common headquarters in New York. The plan first suggested at the conference of committees, viz., the purchase of a house adjoining the present building of the Civil Engineers, had fallen through, the owner being unwilling to sell. The Institute committee would have a further conference with the Civil Engineers' committee in respect to further plans —among them that of the erection of a suitable house large enough to accommodate both societies.

Roadmasters' Association of America.

THE fifth annual meeting of this Association will be held at the Kennard House, in Cleveland, Ohio, beginning at 10 A. M. on Tuesday, October 11, next. The meeting is expected to continue for three days.

The Committee appointed to prepare a programme of questions for discussion at this meeting have submitted the following: 1st. Unfinished business. 2d. Standard Guard Rails for Frogs. 3d. Standard Frogs. 4th. Standard Guard Rails for Bridges and Re-railing Safety Frogs at Bridges. 5th. Standard Track Joints. 6th. Standard Rail. 7th. Standard Hand-Cars.

All roadmasters and track supervisors are respectfully invited to be present at this, the fifth annual meeting of the Association. Arrangements are now under progress whereby it is hoped to arrange with railroad managements to pass all delegates (and their wives) who hold a certificate, issued by the Association, showing him to be a delegate to this convention.

All who can meet with the Association will please notify the Secretary, H. W. Reed, Way Cross, Georgia, of their intention to do so, and he will furnish delegates with certificates, should the several railroad managements consent to honor them in lieu of a pass. Should the Association be denied this mode of transportation, delegates will be promptly notified, in order that each one may make other arrangements for passes.

Those who are not members and wish to join the Association, and cannot spare the time to attend this meeting, may become members by corresponding with the Secretary. Arrangements have been made for special rates at the Kennard House, in Cleveland, thus insuring all who attend a pleasant stay in the city.

Engineers' Club of Kansas City.

A REGULAR meeting of this Club was held July 5, in the Club-room, Vice-President J. A. L. Waddell in the chair; 9 members and 1 visitor present.

It was voted that the regular meeting of the Club on August 1 be omitted, and that in its stead the Club, on Mr. Chanute's invitation, visit the work in progress at that time on the Chicago, Santa Fé & California Railroad bridge over the Missouri River at Sibley.

The Secretary presented for Mr. H. C. Pearsons his regrets at finding it impossible to prepare the paper on Standard Time, which he had promised.

Mr. Waddell mentioned some experiments on the Strength of Cast-Iron Cable Yokes, made in St. Louis recently by Prof. J. B. Johnson and himself.

At the request of Mr. Mason the Secretary read abstracts from the annual address of the retiring President of the Engineers' Club of Philadelphia.

The Secretary presented for Mr. G. W. Pearsons a set of excellent photographs showing the progress of construction on the new Kansas City Water Works at Quindaro and Kaw Point; also from the American Society of Civil Engineers reports of the various committees on Standard Time, with other papers referring to the subject.

American Society of Civil Engineers.

THE annual convention of the Society practically began on Friday morning, July 1, when a large number of members left New York on the Albany Day Line steamboat. At Rhinebeck they landed and were transferred by ferry to Rondout, whence special trains carried them over the Ulster & Delaware, the Stony Clove & Catskill Mountain and the Kaaterskill roads to the Hotel Kaaterskill.

Arrived there, the members were gathered on the grand plateau in front of the hotel, and Mr. William G. Hamilton, Chairman of the Committee on the Convention, presented a very witty address of welcome.

The emblem of the Society—a white flag with the coat-of-arms in the center—was unfurled, after which the members sang an original composition, entitled "Salute to the Flag." All hands then formed a circle, and the wassail cup was passed around.

After singing and the wassail bowl, supper followed, at which each lady was presented with a bouquet of flowers and the compliments of the Society.

On Saturday, July 2, the convention was called to order and Mr. T. C. Clarke was chosen Chairman.

The first business was discussion on the Inspection and Maintenance of Railway Structures. Written discussions were presented by Messrs. John A. Wilson, of Philadelphia; Willard S. Pope, Detroit; Charles A. Marshall, Johnstown, Pa.; Albert Lucius, New York; Andrew Bryson, New York; E. P. Dawley, New York, Providence & Boston Railroad; Samuel T. Wagner; E. S. Philbrick, Boston; J. M. Goodwin, Sharpsville, Pa., and J. M. Wilson. The subject was discussed verbally by Messrs. Theodore Cooper, D. J. Whittemore, Stanley H. Goodwin, A. M. Wellington, P. Roberts, C. C. Schneider, Frederick Graff, Wm. Kent and others.

At the evening session President Worthen read his annual address, which was a summary of engineering progress during the year, and was full also of interesting reminiscences of the past.

Sunday, July 3, there were religious services at the hotel, and a very appropriate sermon was preached by Rev. Mr. Miller, of Philadelphia.

On Monday, July 4, a short session was held, at which Mr. G. H. Thompson read a paper on the old locomotive *De Witt Clinton*. Mr. J. F. O'Rourke read a detailed description of the Poughkeepsie Bridge.

Mr. Collingwood, as Chairman of the Committee on Cement Tests, made a report, which was discussed by Messrs. D. J.

Whittemore, J. M. Worthen, D. F. Noyes, William J. McAlpine, F. C. Prindle, J. F. Flagg, J. Bogart, C. Tompkins, E. P. North, E. Kuichling, E. P. Clarke, P. P. Dickinson and B. F. Church.

In the afternoon a special business meeting was held for the purpose of raising a building improvement fund to be devoted to the improvement of the Society House in New York City, or to erect a building better adapted to the requirements of the Society on some other site. A subscription was started and in less than an hour $5,025 was raised.

In the evening the members attended a ball in the parlors of the hotel.

On Tuesday, July 5, a large number of the members left the Hotel Kaaterskill in the morning to visit the Poughkeepsie Bridge. They were taken from Rondout, on boats provided by the Union Bridge Company, to the bridge. Every portion of the bridge accessible was examined by them, and all were bountifully supplied with refreshments before returning, which was late in the evening. The members who remained at the hotel witnessed a severe mountain storm. The forenoon was misty, followed in the afternoon by a severe storm of both rain and wind. Only a little rain was seen by the members visiting the bridge.

On Wednesday, July 6, Mr. R. E. McMath was called to the chair, Mr. Clarke being absent. Mr. Frederick P. Stearns read a paper on Disposal of Sewage in Massachusetts. A written discussion on this paper, by Charles Allen, was read, and the two papers were verbally discussed by Messrs. E. C. Clarke, Emil Kuichling, R. E. McMath, B. S. Church and W. H. Wiley.

Professor Thurston called attention to the question whether the "Land-grant Colleges" were fulfilling the purposes for which they received donations of public lands.

In the afternoon Mr. G. Leverich read a paper on Cable Railroad Propulsion.

Professor R. H. Thurston presented a blue print taken by a new process. Detailed plans were exhibited showing the method of disposing of sewage in Newark, N. J.

In the evening a business meeting was held, at which Messrs. Wm. H. Paine, Clemens Herschell, Frederick Graff, R. E. McMath and C. H. Latrobe were appointed a committee to nominate officers to be voted for at the annual meeting.

A resolution was then presented by R. E. McMath for the purpose of taking the sense of the meeting:

"*Resolved*, That it is the sense of this meeting that it is expedient to create a grade of *students of the Society*, said grade to consist of young men over 18 and under 25 years of age, who are engaged in the study or practice of engineering. Connection with the Society to cease as each individual student reaches the age of 25, unless he shall be previously elected to a higher grade."

The privileges proposed to be granted by this grade are, attendance at meetings, and to receive the transactions of the Society by the payment of a small fee.

After a long discussion the resolution was referred to a special committee, to be appointed by the President, which is all that could be done by this convention. To make any change in the constitution it will be necessary to submit a resolution at the annual meeting in January, and then, if passed, this resolution will be sent out for ballot to all the members of the Society.

The President appointed on the special committee Robert E. McMath, W. H. Paine, R. H. Thurston, Robert Moore, Frederick Brooks.

Mr. E. P. North introduced the following resolution for the purpose of bringing the subject before the Society, which was introduced by Professor Thurston at a previous meeting:

"*Resolved*, That the Board of Direction of the Society be requested to consider the advisability of appointing a Committee on Technical Education and Professional Training, which shall annually report to the Society the state and progress of such instruction in the United States and Europe as well, together with such data, statistics and suggestions relative to the subject as may seem to them proper. Said committee to co-operate with similar committees of other engineering societies, should such be advisable.

"*Resolved*, That such committees give especial attention to the matter of the formation and administration of those institutions known as the 'Land-grant Colleges,' established by the several States under the Morrill bill of 1862, and report to what extent said colleges are carrying out the original leading objects prescribed by the funds donated under that law have been applied to such leading objects, and to what extent, if at all, diverted from their original purpose; and, further, to report what manner said funds may be in the future, in the opinion of the committee, rendered most useful in the promotion of the industrial arts and the education of the industrial classes."

This was referred to the Board of Direction.

On Thursday, July 7, the Secretary read a letter from an officer of the Panama Canal Company (M. Colné) taking exception to statements made by M. Boulangé at a recent meeting of the Society. The subject was discussed by several members.

A discussion of Professor Robinson's paper on Vibration of Bridges, was read by T. H. Johnson. This was followed by papers by W. H. Booth on Stresses of Bridges; C. A. Marshall on Compressive Strength of Iron and Steel; M. Moulton on the Kentucky & Indiana Bridge over the Ohio at Louisville.

A discussion on A. M. Wellington's paper on the American Line from Vera Cruz to the City of Mexico was read by Mr. O. L. Nichols, and replied to by Mr. Wellington.

In the evening the closing session was held, when the subject of the Maintenance and Inspection of Bridges was taken up again and discussed by Messrs. J. M. Wilson, G. H. Pegram, J. A. L. Waddell, J. Bouscaren, G. Lindenthal and J. S. Dagron.

The convention then adjourned.

On Thursday evening the annual banquet was held at the Hotel Kaaterskill. Mr. W. G. Hamilton presided and 130 members and guests were at the table.

On Friday, July 8, the members left the hotel and went by rail to Kingston. Here some of them continued on their way home, while others left the train for Binne Water to examine the cement works, by invitation of F. O. Norton.

After the inspection of the cement works and lunch the party returned to Kingston and left by West Shore train for New York, where they arrived early in the evening.

An adjourned business meeting was held in New York, July 13. The following were declared elected members: John Ferris Alden, Rochester, N. Y.; Frank M. Ashmead, Hulton, Pa.; Wm. H. Breithaupt (promoted from Junior), Kansas City, Mo.; Ulysses Stanislaus Lutz, Bloomsburg, Pa.; James M. Shanly, Montreal, Canada.

The following circular has been issued:

"At an informal meeting held at the Hotel Kaaterskill on July 4, 1887, at which a number of the members of the Society were present, the President, Mr. William E. Worthen, stated that the Society has grown to such extent that the present house had become inadequate, particularly for the meetings and for the convenient use of the library, and that it seemed of great importance to the welfare of the Society that something should be done either towards building an addition to the present house, or, if it were practicable, the purchase of larger and more commodious quarters.

"The following resolutions were adopted:

"'*Whereas*, the accommodation of the present Society building is entirely inadequate for the purposes of the Society, and it is deemed advisable without delay either to provide new quarters or an enlargement of the present building.

"'*Resolved*, That the members and friends of the Society are urged to contribute to the Building Fund as they may be able, in order that immediate measures may be taken by the Board to accomplish this object.

"'*Resolved*, That the Board in its discretion may expend a reasonable sum in an addition to the present building.'

"The sum of $5,225 was directly subscribed by gentlemen present.

"The Board of Direction desires to take measures either towards the enlargement of the present house or towards the purchase of other property. The determination as to which of these courses shall be taken must depend largely upon the amount of subscriptions to the Building Fund which shall be received within a short time. The subject therefore is presented to the members and friends of the Society. The Board of Direction feels that something must be done, and asks such response as may aid it in determining what is for the best interests of the Society."

Master Mechanics' Association.

Mr. Angus Sinclair, Secretary, issues a circular giving the following list of subjects for the next convention, with the committees appointed by President Setchel to report on each subject:

1. Relative Proportions of Cylinders and Driving Wheels to Boilers: Charles Blackwell, Clem Hackney, J. J. McGrayel.

2. Guides: James N. Lauder, W. J. Robinson, H. S. Kolseth.
3. Extension Smoke-boxes, and Brick and other Fire-box Arches: John Hickey, W. L. Foster, E. L. Weisgerber.
4. Springs and Equalizers: John Mackenzie, J. S. Porter, Wm. Swanston.
5. Tires; Advantage, or Otherwise, of Using Thick Tires: J. W. Stokes, C. E. Smart, Henry Schlacks.
6. Purification or Softening of Feed-Water: Herbert Hackney, John Player, W. T. Small.
7. Prevention of Dangerous Escape of Live Coal and Sparks from Ashpans: G. W. Ettenger, E. D. Anderson, W. H. Thomas.
8. Tender Trucks: E. M. Roberts, H. D. Gordon, H. D. Garrett.
9. Traction Increasers in Connection with Over-Cylindered Engines: J. Davis Barnett, F. L. Wanklyn, T. J. Hatswell.
10. The Magnetic Influence of Iron and Steel in Locomotives on the Watches of Engine-Runners: James Meehan, Harvey Middleton, T. W. Gentry.
11. Amendment of the Constitution: J. Davis Barnett, M. N. Forney, A. Pillsbury, J. N. Lauder, Angus Sinclair.

Committees to prepare Obituaries or Memorials of Deceased Members: On William Woodcock: Thomas Millen, C. G. Williams, L. M. Ames. On H. G. Brooks: M. L. Hinman, George W. Stevens. W. F. Turreff. On George Colby: A. B. Underhill, O. Stewart, John Thompson. On W. W. Evans: M. N. Forney, Reuben Wells, E. H. Williams. On George E. Howe: J. M. Foss, J. T. Gordon, A. Pillsbury.

The address of the Secretary is now No. 175 Dearborn Street, Chicago.

Engineers' Club of Minneapolis.

At a regular meeting held in Minneapolis, Minn., June 24, President G. W. Sublette was appointed a delegate to the convention of the American Society of Civil Engineers. A joint committee was appointed to arrange with the St. Paul Club for an excursion.

On motion the President appointed Messrs. Cappeler, Pike, Houston, Redfield and Pardee a Standing Committee on Tests of Materials, to confer with the State University authorities with reference to a series of tests of local materials to be conducted with a view of correcting the tables on strength of materials.

Car-Wheel Manufacturers' Association.

At a meeting recently held, a number of the manufacturers of car-wheels agreed to form an association for the purpose of discussing questions in connection with the manufacture of car-wheels, the best methods of making and testing wheels and similar matters. Another object of the Association is to endeavor to secure uniform sizes of wheels and uniform methods of testing. With a view to secure the concurrence of railroad officers in some of these points, especially as to a uniform system of testing, the Association appointed a committee to confer with the Master Mechanics and the Master Car-Builders. Both of those associations have appointed committees to confer with the car-wheel manufacturers, thus forming a joint committee which will probably hold several meetings during the year.

The Association does not intend in any way to arrange or influence the prices of wheels, its object being merely to discuss questions connected with their manufacture. Any car-wheel maker can join it, if he desires.

The officers of the Association are: President, W. H. Barnum; Vice-President, J. H. Bass; Secretary, W. W. Lobdell; Treasurer, N. P. Bowler; Executive Committee, J. R. Whitney, W. W. Snow, N. S. Boughton and E. B. Tippetts.

The following is the Constitution adopted by this new Association:

Article 1. *Preamble.*—The object of this Association is for the purpose of securing stated meetings, to interchange views, and consider various subjects as may be thought best for their mutual advantage.

Article 2. *Name.*—The organization shall be known as the Chilled Car-Wheel Manufacturers' Association.

Article 3. *Management.*—The affairs of the Association shall be conducted by a President, Vice-President, Secretary and Treasurer, who, with a board of managers, consisting of five members, shall form an Executive Committee, such officers to be elected at their annual meeting.

Article 4. *Finances.*—The funds of the Association shall be under the control of the Executive Committee, who shall make assessments at such times as may be necessary to meet the actual expenses of the Association.

Article 5. *Membership.*—Anyone engaged in the manufacture of chilled cast-iron car wheels is entitled to membership in the Association by signing its Constitution.

Article 6. *Meetings.*—The Executive Committee shall provide for annual meetings, and for such special meetings as it may deem fit for the interest of the Association, and it shall, at the written request of one-third of the membership of the Board of Managers, call special meetings.

Article 7. *Amendments.*—This Constitution may be altered or amended by a two thirds vote of the members of the Association present, either in person or by proxy, at any of the meetings called for that purpose, with notification of such proposed change, which shall be given 20 days previous to the meeting.

Association of Railroad Telegraph Superintendents.

The sixth annual meeting began at the Tremont House, Boston, July 13, President A. R. Swift in the chair. A number of new members were admitted.

The chief discussion of the first day's session was upon the subject of superfluous and improper messages sent over the railway telegraph wires and the best method for detecting them and enabling the superintendents to abtain tolls on same. It was suggested that a committee be appointed to ascertain if an instrument could be devised and manufactured for the purpose of detecting and recording all messages passing over the wires and to be termed an automatic recording register. After the unanimous vote of those present in favor of this suggestion, it was decided upon that the committee referred to should visit the great commercial telegraph offices in New York, and there inspect the various kinds of apparatus in use. President Swift appointed the following committee for the purpose named: Messrs. S. S. Bogart, W. J. Holmes, C. E. Topping, C. Selden and M. Magiff. It was then agreed upon that this committee be authorized to extend an invitation to manufacturers of recording instruments to submit plans for a recording register which would meet the requirements of the members of the Association.

After inspecting a number of exhibits of electrical apparatus, the members went on a steamboat excursion to Nantasket Beach.

On the second day Mr. G. L. Lang, Chairman of the Committee on the Alphabet, reported on the advisability of substituting something in place of the long dash to represent the cipher. While the desirability of some substitute was acknowledged, no agreement could be reached as to what to substitute, and the Committee, therefore, made no recommendation. There was an interesting discussion on the report, and, while all of the speakers acknowledged that some change ought to be made, inasmuch as the same symbol is used to represent the letter L and the cipher, no one suggested any substitute. It was finally voted to instruct the Committee to decide for the association upon some symbol. Mr. Lang declined to serve longer, and the committee was constituted as follows: Messrs. Selden, Holmes and Topping.

It was voted to hold the next meeting in New York on the second Wednesday in July, 1888. The Association proceeded to the election of officers, which resulted as follows: President, George L. Lang, New York & New England; Vice-President, G. C. Kinsman, Wabash; Secretary and Treasurer, P. W. Drew, Chicago & Eastern Illinois.

A general discussion took place upon the use of electricity in connection with track signals, lighting of cars, etc., and various gentlemen told about their acquaintance with the subject on their own lines of railroad.

After a short discussion on the Telegraphers' Union and some routine business, the convention adjourned.

Fast Steamers.—The fast time made by the steam yacht *Stiletto*, built by the Herreshoffs at Bristol, R. I., attracted much attention last year. As has been already noted, the *Stiletto* has been sold to the Navy Department. The Herreshoffs have just completed a yacht for Mr. N. L. Munro, of New York, which made on its trial trip from Newport to New York an average speed of 24 miles an hour. This yacht, which is named *Now Then*, has the following measurements: Length over all, 85 ft.; water line, 81 ft.; beam, 10 ft.; draft of water, 3 ft. 3 in. Her speed, however, does not quite equal that attained by some English torpedo-boats.

PERSONALS.

Mr. F. T. Perris is Chief Engineer of the new California Central Railroad.

Mr. Charles M. Babbitt is Chief Engineer in charge of the location of the new Arkansas & Louisiana Railroad.

Mr. C. H. Prescott has resigned his position as Manager of the Oregon Railway & Navigation Company's lines.

Major James F. Gregory, U. S. Engineers, is assigned to duty as Engineer Secretary of the Lighthouse Board.

Lieutenant-Commander John K. Winn has been ordered to duty as Inspector of the Seventh Lighthouse District.

Mr. J. A. Cooper has resigned his position as Master Mechanic of the New York, Pennsylvania & Ohio Railroad.

Mr. John Adair has been appointed Master Mechanic in charge of the Baltimore & Ohio shops at Grafton, W. Va.

Mr. T. P. Jacob has resigned his position as Master Mechanic of the Third Division of the Mexican Central Railway.

Captain John C. Mallery, U. S. Engineers, is assigned to duty as Engineer of the Fifth and Sixth Lighthouse Districts.

Major David P. Heap, U. S. Engineers, is assigned to duty as Engineer of the Third and Fourth Lighthouse Districts.

Mr. Frederick Mertzheimer has been appointed Master Mechanic of the Kansas Division of the Union Pacific Railway.

Lieutenant-Commander Joseph F. Noel, United States Navy, has resigned his commission, to take effect immediately.

Mr. George Leighton is Chief Engineer of the Mobile & Dauphin Island Railroad, and has his office in Mobile, Alabama.

Mr. W. Bradburn has been appointed Resident Engineer of the Texas & Pacific Railway, with headquarters at Marshall, Texas.

Mr. G. C. Dunham is appointed Engineer of the Lake Shore & Michigan road, in place of O. D. Richards, transferred.

Mr. Jonathan Barrett is Chief Engineer of the new West Virginia Railroad, and has his headquarters at Morgantown, W. Va.

Mr. Samuel W. Armistead has been appointed Assistant Naval Constructor in the United States Navy, to date from June 30.

Mr. O. H. Tripp, of Rockland, Me., is Chief Engineer of the Camden, Rockport & Rockland Railroad, now under construction.

Mr. Charles M. Hays is appointed General Manager of the Wabash Western Railroad, to succeed A. A. Talmage, deceased.

Lieutenant J. V. B. Bleecker, U. S. N., has been ordered to duty as inspector of steel for the new cruisers now under construction.

Mr. W. A. Pratt has been appointed Engineer of Maintenance of Way of the Philadelphia Division of the Baltimore & Ohio Railroad.

Mr. Samuel Eagan has been appointed Master Mechanic of the Colorado Division of the Union Pacific Railway, with office in Denver.

P. E. Le Fevre, U. S. N., has been appointed Superintending Engineer of the Ocean Steamship Company, with office in New York.

Mr. H. B. Hodges, Chemist of the Union Pacific Railway, has been made Acting Engineer of Tests in place of C. H. McKibbin, transferred.

Mr. Elliott Holbrook, late Chief Engineer of the Pittsburgh & Lake Erie Railroad, has been appointed General Superintendent of that road.

Lieutenant J. M. Robinson, U. S. N., has been detached from the *Minnesota* and ordered to duty as Inspector of steel for the new cruisers.

Mr. C. H. McKibbin, late Engineer of Tests of the Union Pacific Railway, has been appointed Storekeeper of the road, with office in Omaha.

Captain Richard W. Meade, U. S. N., will take command of the Washington Navy Yard in September, relieving Captain Rush A. Wallace.

Major Joseph P. Farley, U. S. Ordnance Corps, is assigned to duty as a member of the board for testing rifled cannon, with station at New York.

Colonel William Kerrigan has resigned his position as General Superintendent of the Missouri Pacific Railway, and will engage in other business.

Captain Otto E. Michaelis, U. S. Ordnance Corps, is assigned to the command of the Kennebec Arsenal, Maine, relieving Major Frank H. Phipps.

Mr. A. M. Miller is appointed Master Mechanic of the Cascade Division of the Northern Pacific Railroad, with office at Ellensburg, Washington Territory.

Major Frank H. Phipps, U. S. Ordnance Corps, is assigned to the command of the United States Powder Depot, Dover, N. J., relieving Major Joseph P. Farley.

Mr. S. B. Crawford has been appointed Master Mechanic of the Baltimore & Ohio Railroad shops at Mt. Clare, Baltimore, in place of Adam Beckert, resigned.

Commodore James A. Green, U. S. N., has been detached from duty as President of the Naval Examining Board, and ordered to command the European station.

Mr. O. D. Richards is appointed Engineer of the Michigan Southern Division of the Lake Shore & Michigan Southern Railroad, in place of Benjamin Reece, resigned.

Mr. George W. West has been appointed Master Mechanic of the Eastern Division of the New York, Pennsylvania & Ohio Railroad, succeeding J. A. Cooper, resigned.

Dr. Thomas B. Comstock, Professor of Mining Engineering in the University of Illinois, at Champaign, has been appointed Assistant Geologist for the State of Arkansas.

Mr. T. Tresize has been appointed Master Mechanic of the Philadelphia Division of the Baltimore & Ohio Railroad. He was recently General Foreman of the shops at Sandy Hook.

Mr. H. S. Rowe, Superintendent of the Oregon Railway & Navigation Company's lines, will hereafter perform the duties of Manager, in place of Mr. C. H. Prescott, who has resigned.

Mr. Washington Lavery has been appointed Master Mechanic of the Mahoning Division of the New York, Pennsylvania & Ohio Railroad, succeeding George W. West, transferred.

Mr. Charles Macdonald, of the Union Bridge Company, has started for Australia, on business connected with the Hawkesbury Bridge. He expects to be gone three or four months.

Mr. William F. Durfee, a well-known metallurgist and engineer, has been appointed General Manager of the Pennsylvania Diamond Drill Company, whose works are at Birdsboro, Pa.

Mr. George Gibbs has been appointed Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railway, and will have his headquarters in Milwaukee. He has been Engineer of Tests for some time.

Mr. James Carton has been appointed Roadmaster of the Gulf, Colorado & Santa Fé Railroad, with headquarters at Fort Worth, Tex. He was recently on the Jeffersonville, Madison & Indianapolis road.

Mr. E. L. Corthell, who, for three years has held the position of Chief Engineer of the Tehuantepec Ship Railway is to retain that position. The report that Colonel Andrews, of Allegheny, Pa., is to take this position is without foundation.

Mr. W. P. Freret, has been appointed Supervising Architect of the Treasury Department in place of M. E. Bell, resigned. Mr. Freret is a well-known architect of New Orleans, and has had charge of some important works in that city.

Mr. Robert B. Lyle, for some time past connected with the Missouri Car & Foundry Company, and formerly Purchasing Agent of the Missouri Pacific Railroad, has been made Manager of the St. Louis branch house of Park Brothers & Co., Limited.

Mr. W. C. Quincy has resigned his position as General Manager of the Pittsburgh & Lake Erie Railroad. He has had charge of that road since its first construction. Mr. Quincy has accepted a position with the large iron house of Jones & Laughlins, in Pittsburgh.

Mr. George S. Rice has been appointed Deputy Chief Engineer of the New Croton Aqueduct for New York City. He has been connected as Assistant Engineer with the waterworks of Lowell, Mass., and Boston, and was recently Principal Assistant Engineer of the new sewerage system of Boston.

M. Adolph Greiner has been chosen Director-General of the great works of the Société John Cockerill, at Seraing, Belgium, in place of Baron Sadoine, who retires. M. Greiner has been connectedwith these works ever since he graduated from

the School of Mines at Liège, and has been for several years head of the Steel Department.

Mr. Edward Nichols, who succeeds the late H. G. Brooks as President of the Brooks Locomotive Works, is an engineer by profession, having graduated from the Rensselaer Polytechnic Institute. He has for a number of years been connected with large iron and steel interests in Pennsylvania. He was recently President and Superintendent of the Ridge Valley Iron Company, of Georgia, and Vice-President of the Warren-Scharf Asphalt Paving Company of New York.

NOTES AND NEWS.

Narrow-Gauge Changes.—The Toledo Division of the Toledo, St. Louis & Kansas City Railroad has been changed from 3 ft. to standard gauge. The section changed is 206 miles long. The St. Louis Division of the road will be changed shortly.

The John Scott Medal.—The City of Philadelphia, on the recommendation of the Franklin Institute, according to custom, has awarded the John Scott Medal and premium to the Hall Steam Pump Company, of New York and Wilmington, Del., for its Duplex Steam Pump.

Philadelphia Elevated Railroads. — Two organized companies—the Consolidated Transit and the Philadelphia & Northeastern—are now applicants for rights to build elevated railroads in certain streets in Philadelphia. Both have offered to pay considerable sums for the concession.

Baltimore & Ohio Employes Relief Association.—The May report shows payments of $26,606 in benefits to 1,007 members of this Association. There were 4 deaths from accident and 14 from disease; 331 cases of accidental injury and 533 of sickness. In addition there were 125 physicians' bills paid.

Iron in Brazil.—Large deposits of magnetic iron ore have long been known to exist in Brazil, and several mines have been opened up in the Iquape District. Experiments have shown that iron of a very fine quality can be made from this ore. It is now proposed to establish iron works in connection with the mines.

German Rail Contracts.—The *Moniteur Industriel* (Brussels), asserts that the German railmakers have formed a pool or syndicate, the object of which is practically to exclude from all contracts in Germany the John Cockerill Works at Seraing, Belgium. These works have heretofore furnished large quantities of rails to Germany.

Brooklyn Elevated Railroads.—The new elevated railroad—the Kings County line—is now under construction at a rapid rate, the legal obstacles having been removed by a decision of the Court of Appeals. The foundations are completed for 4½ miles and the superstructure about a mile. Contracts for equipment have been let, and the road will probably be in operation by December next.

Oil Barges.—The Standard Oil Company has contracted with John Roach's Sons, Chester, Pa., for the construction of an iron barge for carrying oil in bulk in the coastwise trade. The barge will be 153 ft. long, and have 275,000 gallons capacity. She will be towed in the same manner that the coal barges are to the coastwise ports. If this barge proves a success further contracts will be given.

Bridging the British Channel.—M. Arnaudeau, in the *Revue Scientifique*, proposes a bridge from Dover to Calais, which shall carry a pneumatic tube large enough to transport the mails and small packages. His plan is to build towers some 400 ft. high above the water level and about half a mile apart, and to suspend the tube from these towers by wire cables. The towers are to be of such size that additional tubes can be added, if needed. The tubes can also carry telegraph and telephone wires.

High-Pressure Steam for Steam Jackets.—It is now recommended by some English engineers that the steam for the cylinder jackets of compound engines should be generated in a special boiler, and of a higher pressure than the steam used to drive the engine, and that as high a piston-speed should be obtained as can, with safety, be adopted—as in engines with a high piston-speed, everything else being taken into consideration, there was not the same initial and permanent condensation taking place in the cylinders.

Petroleum by Caravan.—A letter from Baku in the Transcaucasus, Russia, says that a new market has opened for the petroleum produced there. A company has been formed at Baku by several owners of camel caravans for the purpose of introducing petroleum into Persia by the overland route through Mughan. Several caravans have been sent, but they did not get beyond Mughan, because in each case the oil was all sold there. It is now intended to increase the caravans to 500 camels each, and it is expected that a considerable trade can be built up.

Prizes for Engineering Papers.—The Director General of Roads and Bridges in France, under authority from the Minister, has recently awarded prizes for papers written during the past year, as follows: Gold medal, 600 francs, to M. A. Considère, Chief Engineer, for his paper on the Use of Iron and Steel in Construction; gold medals, 200 francs, to M. R. Barabant, Chief Engineer, for his paper on Studies of Travel in London, and to M. A. E. Hetier, Chief Engineer, for his paper on Resistance of Materials in Sustaining Walls.

The Siberian Railroad.—It is stated that the Russian Government has resolved to push work on the Siberian Railroad, with a view to completing it within five years. This line is now completed to Ekaterinberg, and work is in progress from that point to Tiumen. The new plan is to begin work at once on the section from Tiumen to Tomsk, the capital of Western Siberia. From Tomsk the road will run to Irkutsk and thence to Stretinsk or Boorsa on the Amoor River, whence steamboats run down the river to Vladivostock, the Russian naval station on the Pacific.

Large Lake Vessel.—The new steel steamship *Oswego* was launched at Buffalo, July 7. She is owned by the Union Steamboat Company, and her dimensions are: Length over all, 357 ft.; between perpendiculars, 326 ft.; molded depth at lowest point, 25½ ft.; beam molded, 41 ft. She is expected so carry 2,800 tons of cargo on 15½ ft. draft of water. She has a double bottom 3 ft. deep, which can be filled with water, giving her about 800 tons of ballast. The *Oswego's* engines are of the triple-expansion pattern, with cylinders 28, 42½ and 72 in. in diameter and 54 in. stroke. There are six boilers, the working pressure on which will be 160 lbs.

Heavy Gun Lathes.—The two lathes built for turning and boring heavy guns are to be removed from the South Boston Iron Works to the Watervliet Arsenal at West Troy, N. Y. One of these lathes weighs 145 tons and the other 175 tons, and both can take in work 40 ft. long. With them is a crane built purposely to lift the guns and put them in position on the lathe. One of the great lathes was built at South Boston, the other at the Springfield Arsenal; both are the property of the Government. Several 10-in. and 12-in. guns have been turned on them.

At the Watervliet Arsenal preparations are in progress for the establishment of an extensive plant for making heavy guns for the army.

Steel Castings for Ships.—June 18, the Standard Steel Works, Thurlow, Pa., cast a steel stern-post for gunboat No. 1 and an engine bed-plate for the cruiser *Baltimore*, which vessels are being constructed at Cramp's yards, at Philadelphia. The stern-post, weighing 15,000 lbs., was cast without a defect.

The steel stern-post for the cruiser *Charleston* was successfully cast at San Francisco, June 22. The post is 22 ft. long on the keel, with an upright of 20 ft. and weighs upward of 15,000 lbs. It was claimed by the eastern competitors for the building of the cruisers that a post of the size necessary could not be cast on the Pacific Coast. The work was done by the Pacific Rolling Mill Company, which added to its extensive plant an open-hearth-steel department in 1884.

Iron and Steel Production. — The American Iron & Steel Association reports production for the first half of 1887 as follows, in net tons, the comparisons made being with the first half of 1886:

	1887.	1886.
Pig iron	3,417,903	2,954,209
Spiegeleisen and ferro-manganese	25,436	24,382
Bessemer steel ingots	1,637,572	1,073,663
Bessemer steel rails	1,154,193	707,447
Open-hearth steel ingots	1,74,400	92,540
Open-hearth steel rails	....	12,396

There was a falling off in bituminous pig, owing to scarcity of coke, but an increase in charcoal and anthracite iron. The stocks of pig-iron unsold June 30 was about the same as on January 1.

There are 31,043 tons of steel made by the Clapp-Griffiths process included in the Bessemer steel. Rails absorbed a very large part of the steel production for the half-year.

Cast-Steel Guns for the Navy.—On July 20 the Secretary of the Navy issued the following order:

"The Department has decided to postpone until September 20 the opening of proposals for the furnishing of steel cast guns for the Navy. This action is taken in order to give more

time to domestic manufacturers to consider the matter. The intention of Congress in making the appropriation was doubtless to enable experiment to be made with steel cast guns, and it will be the desire of the Department to meet liberally domestic manufacturers of steel who wish in good faith to submit to the department castings for the purpose in view. The act of Congress has fixed the test to which the finished gun must be subjected. It is the same test as that which the guns now being made by the Department safely stand. No gun finished by the Department has failed thus far upon that test. It is not deemed severe and is not supposed to represent at all the limit of extreme strength nor the capacity of the guns."

Railroad Axle Boxes with Paper Bearings.—Experiments are now being made on the Prussian State railroads with a passenger car fitted with Ulffer's axle boxes, in which the brasses are replaced by bearings made of segments of vegetable parchment, placed side by side and strongly compressed. The friction takes place between the body of the journal and the thin edge of the parchment segments, and according to the inventor the surface of his bearings is harder and in a better condition than that of any metal bearing. Care must be taken when building up the parchment bearings to have the material thoroughly dried, in order to prevent subsequent shrinkage, accompanied by buckling of the sheets. On the outside of these bearings are placed wooden rings, which fit the collars of the journal. These bearings may be lubricated either with an emulsion of water and oil, or with any of the usual mineral lubricating oils. The mass of the parchment becomes more or less impregnated with the lubricant, and thus the bearings may be left to run for comparatively long periods without renewing the lubrication. Some of these bearings have also been fitted in a saw mill at Ueckermünde, and have given perfect satisfaction.—*Industries.*

Triple-Expansion Engines.—The mail steamship, *Trojan*, built and engined by Messrs. J. & G. Thomson, of Clydebank, Glasgow, for the Union Steamship Company's Cape of Good Hope mail service, has had her engines converted from the compound to the tri-compound system by Messrs. T. Richardson & Sons, of Hartlepool, and has been supplied with new boilers working at a pressure of 160 lbs. per square inch. The diameters of the new cylinders are 34 in., 54 in. and 89 in., respectively, and the length of the stroke 60 in. The *Trojan* went out for her trial trip at Stokes Bay on May 28. She attained a mean speed of 13 9 knots per hour and indicated 4,092 H. P., her engines working at 66 revolutions per minute, with a steam pressure of 160 lbs. to the square inch. This shows an additional 530 indicated H. P., as compared with the *Trojan's* trial trip with the compound engines. The *Trojan* is the third of the Union Company's mail steamers which has been converted to the new system, and it is confidently anticipated that the result will be as satisfactory as in the case of the two others, the *Spartan* and the *Athenian.* The *Mexican* is now having her engines tripled, and will be followed, on her completion, by the *Moor.* The intercolonial steamers *Anglian* and *African* are also fitted with triple-expansion engines.

Drainage of Chicago.—The drainage of Chicago has always been difficult owing to its large area and to the fact that its site was originally a level prairie, only a few feet above the surface of Lake Michigan. It is therefore impossible to get fall sufficient for the drain, and as the lake is practically without tides or currents, and the water supply of Chicago is drawn from the lake, it is not a desirable receptacle for the sewage.

The Illinois River, which empties into the Mississippi, flows in a southwesterly direction, almost across the whole of the State of Illinois. A tributary—the Desplaines River—rises within a few miles of Chicago. This river is separated from Lake Michigan by a lime-stone ridge. Near Joliet, about 35 to 40 miles from Chicago, this river is 75 to 80 ft. lower than the extreme low-water level of the lake.

At a recent meeting of the Grant Club in Chicago, Mr. Gordon H. Nott read a paper in which he advocated the construction of a tunnel commencing in Chicago at about 40 ft. below the level of the lake and connecting with the Desplaines River, near Joliet. He proposes a system of precipitating basins, in which the solid portions of the sewage is to be collected.

The estimated cost is between nine and ten million dollars.

A New French War-ship.—A first-class ironclad, the *Marceau*, has just been launched at La Seyne-sur-Mer, near Toulon. The total length is 338 ft., with a width of 66 ft. and a depth of 43 ft. She draws 26 ft. of water and has a total displacement of 10,582 tons. The spur placed in her bow is of bronze and is 10 ft. long. The hull is all made of steel except the keel, which is iron. She has three full decks, and is divided into 15 transversal, water-tight compartments internally. The weight of the hull is 3,875 tons, and the plates on the ironclad deck are 4 in. thick, and they extend the full length of the vessel. The engines, boilers, powder magazines, and the apparatus to be used for manœuvring the heavy artillery, will be well protected, the weight of the plates on the sides of the vessel, the deck, and the turrets exceeding 3,000 tons. The weight of the engines is about 626 tons, and that of the boilers about 341 tons. The trial speed of the *Marceau* is fixed at 18 knots an hour. She is to be armed with four 14-in. guns placed in four barbette turrets, which are placed in the longitudinal axis of the vessel, one forward and another astern, with two others in the lateral axis. The small artillery will include seventeen 6-in. guns in the battery, while revolving and rapid-firing guns will be placed in various parts of the vessel. There will also be four torpedo tubes.—*Engineering.*

Russian Steamboats on the Volga.—The Russian steamboat service on the River Volga, which has been largely developed and much improved of late years, has been increased during the last few weeks by two more steamers of the American type, purchased for $105,000 each by the Samolet Company. These vessels, called respectively the *Pushkin* and *Lermontoff*, are 254 ft. long and 50 ft. broad, provided with engines of 180 normal or 800 indicated horse-power, steaming at 18 miles an hour. Each will carry 1,500 passengers and about 130 tons of cargo. American type steamers are very popular in the Volga and are used by most of the large companies, the Kavkaz & Mercury Company, which carries the mails on the Caspian, having no less than 11 of them. One of its vessels, the *Suvoroff*, is 286 ft. long, 35 ft. broad, and has engines of 1,500 I. H. P. During the great fair at Nijni Novgorod, it carries 2,000 passengers each trip, besides 500 tons of cargo. The Zeveke Company has five vessels 280 ft. long and 40 ft. broad, with engines of 1,000 I. H. P., which carry a still larger number of passengers. Latterly, the same company has built five stern-wheelers. Great breadth of beam and plenty of saloon accomodation are the favorite features of these vessels, which have to run long trips of five to seven days duration up or down are Volga, between Nijni Novgorod, and Astrachan, and the rarely exposed to rough weather, for which their light construction hardly fits them.

Blast Furnaces of the United States. — The *American Manufacturer*, of Pittsburgh, says: "In a condensed form, the statistics of the furnaces for July 1, are as follows:

	In blast.		Out of blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	77	13,969	101	10,578
Anthracite	136	37,662	66	16,624
Bituminous	101	53,355	112	59,014
Total	314	104,986	279	86,216

"As compared with last month there is but little change in the totals, 314 furnaces being in blast July 1, as compared with 311 June 1; the total weekly capacity of the furnaces in blast June 1 being 107,964 tons, and of those in blast July 1, 104,986, the explanation of the greater capacity with less furnaces in blast June 1 being that a larger proportion of charcoal furnaces are in blast July 1 and a less number of coke.

"As compared with a year ago, the number of the furnaces in blast is as follows:

	July 1, 1887.		July 1, 1886.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	77	13,969	59	10,420
Anthracite	136	37,662	119	33,225
Bituminous	101	53,355	132	28,005
Total	314	104,986	310	71,650

"Some of the changes, especially in the bituminous furnaces, are due to special causes, such as the strike in the coke regions of Pennsylvania."

Aluminium and Wrought-Iron.—Recently we had occasion to refer to some successful experiments in the manufacture of cast-steel, free from blow-holes. The results were due to the admixture to the steel of 0.1 per cent. of aluminium. During the week just closed, experiments were made with puddled iron in charges of 500 lbs. The results were by no means conclusive, but enough was shown to illustrate the advantages of combining aluminium with iron. Strangely enough, the charges containing the low percentages of alloy turned out the strongest material. So, for instance, the addition of 0.1 per cent. aluminium raised the tensile strength from 52,000 lbs. to 60,000 lbs., an increase of 16 per cent., while the elongation was variously increased up to 21 per cent. One of the tests conformed to the method of testing marine steel, the elongation of the 1-in. test-spot being 0.1875 per cent. or $\frac{3}{16}$ in.

What may be done with puddled iron is shown by experiments conducted by Mr. Graham W. Thompson, a leading iron manufacturer of Glasgow. The tensile strength of ordinary puddled iron, 22 long tons with 12 per cent. elongation, was, by the addition of 0.25 per cent. of aluminium, increased to 31 long tons with 23 per cent. elongation. When mixed in equal parts with ordinary stock, this treated material still showed a tensile strength of 28 English tons, with 8.28 per cent. elongation; and a third mixture of the already reduced stock with common stock resulted in a tensile strength of 25 tons, with 7 per cent. elongation. The experiments with puddled iron will be pursued in other ways until some fixed rule of procedure may be established.—*Cleveland Iron Trade Review.*

Grade Crossings in Massachusetts.—The report of the Massachusetts Railroad Commission for 1886 says:

"The number of crossings of railroads and highways at grade, according to the returns, is 2,138, of which 738 are protected by gates or flagmen.

"Seventeen grade crossings have been allowed during the year. Only one of them was an important one, and it was permitted because by such action the abolition of two like crossings was secured. Some of the others merely took the place of crossings now existing, some were crossings over streets that only exist on paper, and a few were granted because they were absolutely necessary.

"The Act of 1885, chap. 197, designed to promote the abolition of grade crossings, has proved useful, especially on the Old Colony Railroad, where 10 level crossings have been abolished. It is to be hoped that other companies will follow the good example set by this company in expending time and money to rid the public of the dangers arising from this cause.

"If legislation is needed to facilitate the reduction of the perils arising from this source, we believe that the General Court is ready to act. We repeat our suggestion, that a railroad company resisting the creation of a new grade-crossing is not to be regarded as a public enemy; acting only from selfish motives, And we renew the proposition, that where a new highway is laid across a railroad, some tribunal may be empowered in fit cases to apportion among the proper parties the expense caused by the construction of a bridge, notwithstanding the fact that the railroad is the 'first comer.' Such an act would check the demand for grade-crossings, relieve towns from apparent hardship, and remove a source of great discontent."

Electric Street Railroads.—The New Brunswick City Railroad Company, at New Brunswick, N. J., has applied to the City Council for permission to use electric motors of the Van Depoele system on its cars.

The officers of the Belt Line, in New York City, nearly all of whose cars and horses were recently destroyed by fire, are considering the question of adopting some electric motor on their road.

A car operated by an electric motor actuated by storage batteries on the Julien system has been making experimental trips on the Fourth Avenue line in New York City. These trips were very successful.

Work is now in progress on a cross-town line running from Fulton Ferry to Chambers Street Ferry in New York. This line is to be operated by electric motors on the Bentley-Knight system, the electric current being carried through an underground conduit, connection being made by a contact-plow carried on the car or motor.

An experimental car is now at work in Philadelphia which is propelled by an electric motor deriving its power from storage batteries of the system used by the Electrical Accumulator Company, of New York.

It is proposed to use electric motors on some of the street-car lines in New Orleans, but no decision has yet been reached as to the kind of motor to be used.

The Union Passenger Railroad Company in Richmond, Va., is laying some 13 miles of track, on which electric motors will be used. The power will be taken from two overhead wires carried on poles, and the cars will be equipped with the Sprague motor. In cold weather the cars are to be heated by an electric apparatus invented by Dr. W. Leigh Burton, of Richmond.

Basic Slag as a Fertilizer.—The Birmingham correspondent of the *Engineer* writes that a machine plant has just been erected at the works of the Staffordshire Steel & Ingot Iron Company for the reduction to a fine powder of basic slag for fertilising purposes. This is practically a new industry, not only for the district but for England, since, although slag is being exported in large quantities from the works of the Northeastern Steel Company, Middlesbrough, for this purpose, the product is exported almost wholly to Germany, where, by special plant, it is reduced to an exceeding fineness, sufficient for agricultural purposes, and is exported back again to this country, where it is commanding a price of 30*s.* per ton, delivered in the Thames, and is having a large sale.

The plant has been supplied by Messrs. Morris Brothers, engineers, of Doncaster, and is very similar to that employed in grinding super-phosphates. It consists of one preparing mill fitted with Wood's patent separator; one magnetic separator; and one Morris & Wood's patent fine mill. The whole is driven by a powerful compound engine by Robey & Co., of Lincoln, of about 30 nominal H. P., or 80 actual H. P. The process of pulverizing the slag is divided into three stages—first, the slag is fed into the preparing mill in its rough state, and is reduced to about $\frac{1}{16}$ in., and any pieces of steel exceeding that dimension, accumulating in this mill, are taken out at intervals. During this preliminary reduction a quantity of fine slag is produced, and is extracted by the separator before the reduced material passes to the second stage, during which a magnetic separator extracts the small pieces of steel. The reduction of the material at the last stage enables it to pass through a mesh of 10,000 holes to the square inch—an obvious advantage, since the value of the material greatly depends upon its fineness.

An extensive plant for similar purposes is also, I understand, being erected at the Northeastern Steel Works, who intend to supply the ground material to home agriculturists, instead of allowing the Germans to do the trade.

The East Boston Electric Freight Railroad.—The ease and slight expense at which an electric railroad can be operated in large works already provided with a dynamo for electric lighting is well shown in the venture recently carried out by the East Boston Sugar Refinery at East Boston. This refinery, which is the largest in New England, is situated about 1,300 ft. from the docks where the raw sugar is unloaded from the ships. Formerly the hogsheads and bags were loaded on a railroad truck drawn by horses, the work being such as to tax the animals very severely and necessitating frequent changes.

As the refinery is provided with a 150-light Edison plant, it was determined to put in an electric railroad, and the installation was undertaken by the Sprague Electric Railway Motor Company of New York.

The rolling stock consists of two flat cars, one of which carries the motor of 15 H. P. at its forward end, together with a raised platform, upon which are placed the regulating and reversing switches. The cars are capable of taking a load of 12 hogsheads, equivalent to 30,000 lbs. The current is taken from the lighting dynamo and led to the motor from an overhead wire and trolley, the track being used on the return.

With the electric railroad the work of transferring can be done in one-fourth the time formerly required with horses; and although ships are constantly unloading at the docks the limiting capacity of the railroad to handle the work has not yet been reached.

The motor operates without noise, and although the track is always in bad condition, being invariably covered with sugar and molasses, no difficulty in operation has yet been experienced. Another interesting feature is the fact that thus far no appreciable increase in coal consumption due to the operation of the electric railroad in connection with the lights has been noticed.—*Electrical World.*

The Transcaspian Railroad.—The Russian *Official Messenger*, speaking of the works on the Transcaspian line, says: "In 1886, the Transcaspian Railroad line commenced upon the eastern shore of Gulf Mikhailovsky, at the station of Mikhailovskoe-Turkmenskoe. The shallowness of this gulf made it accessible only to vessels with a very small draught of water, and the sinuosities of a canal 40 versts long, marked out by a double row of stakes, was a serious obstacle to navigation. As a rule, the passengers were obliged to get out of the train at Krasnovodsk and get on board a small vessel, which could only travel by daylight, all this causing a great loss of time and considerable expense. In order to facilitate communications with the Transcaspian Province, it therefore became necessary to prolong the railway line to a point along the coast which could be reached by vessels with a deep draught of water. The Bay of Krasnovodsk answered these requirements, but the road leading to it was some distance from Mikhailovskoe, and very hilly, so that a railway in this direction would have been very dear. The result of an exploration made by the order of General Annenkoff went to show that in the vicinity of the island of Uzun-Ada, upon the route leading to the Bay of Mikhailovsky, there was a bay which, with a very slight outlay for dredging, would answer all purposes. The work was soon effected, and a small town named Uzun-Ada has already been built upon

the southern coast of the Dardja Peninsula. This has already proved of considerable service, in that it has enabled the engineers to receive from Astrachan, without break of bulk, all the materials required for the construction of the Amu-Daria line. As the canal leading to Uzun-Ada is very narrow and sinuous, it has been marked out with a double row of posts, to which are attached lanterns lighted with photogene. The whole Transcaspian line, from the station of Uzun-Ada to the Amu-Daria, has a total length of 1,011 versts, of which 794 were constructed in a little more than a year. All the materials were brought down the Volga from Astrachan. At present the regular trains run upon the new line twice a week."

Russian and English Government Engineering.—The London *Engineering* says: "The departure of General Annenkoff to supervise the construction of the railway from the Oxus to Samarcand and Tashkent, contrasts forcibly with the news from India that the Indian Government is only now beginning to think of surveying the country for twelve miles ahead of Peshawur, in the direction of Cabul. It is a well-known fact in military circles that the plans of the Indian Government for the defense of India against Russia, provide, among other things, for the immediate construction of a railway to Cabul, the moment Russia attempts the invasion of Afghanistan. On the first intimation of war, troops would at once march to Cabul to help the Ameer, and the Peshawur Railway would follow as swiftly as possible through the Khyber Pass to help them. Such being the plan that has existed on paper since the last war scare two years ago, one would have naturally thought that the Indian authorities would have long ago surveyed the country for the line, and prepared the working drawings for its rapid construction. Instead of which, it is only now that the government is concerning itself about the survey, and thinks its efforts equal to the occasion when it confines the survey to twelve miles, or a single march, out of the total distance between Peshawur and Cabul. Considering that our relations with the Ameer are of a most amicable character, that we pay him 10,000*l*. a month, and there is a regular stream of safe traffic constantly between Peshawur and Cabul, it ought not to have been impossible to have obtained a survey long ago—even a rough one, taken by engineers in disguise, would have been better than none at all. Neither the government in India nor the authorities at home appear to realize that Russia's engineering activity in Central Asia will tell more on the fortunes of the next campaign than any other conceivable factor. While we are content to defend India by ordering the survey—only the survey—of twelve miles of frontier line, Russia, in spite of her financial difficulties, is boldly commencing the construction of 500 miles more, to add to the 700 already constructed from the Caspian to the Oxus, and makes no secret that the railway is intended purely for purposes inimical to our rule in India."

The Iron-Worm.—The London *Ironmonger* gives the somewhat alarming statement, "from a German source," that the existence has just been discovered of a detestable microbe, which feeds upon iron with as much gluttony as the phylloxera upon the vine. Some time ago the greatest consternation existed among the engineers employed on the railroad at and near Hagen by the frequency of accidents occurring at a certain point, which seemed to prove that some serious defect must exist either in the material or construction of the rails. The German Government ordered that a strict inquiry be made, and a commission of surveillance be formed for the purpose of keeping close watch at the spot where the accidents had taken place. It was not, however, until six months had elapsed that the discovery was made. One of the trackmen had observed that the surface of the rails seemed to be corroded, as if by some acid, for a distance of about 280 ft. The rails were taken up and were found to be in very bad condition, several of them breaking into three or four pieces when the men tried to lift them. When these rails were carefully examined, it was found that they were literally hollowed out by a thin gray worm, to which the qualification of "Railoverous" was assigned; by this name it will be known in natural history. This worm is from 6 to 9 millimeters in diameter, and from 20 to 25 millimeters in length. It is of a light gray color, and has on its head two glands filled with a corrosive secretion, which it ejects at intervals of 5 or 10 minutes, and which has the effect of making the iron soft, spongy and of a light red color. It is then devoured greedily by the insect, which seems to have an insatiable appetite. These worms, it is stated, destroyed no less than 36 kilogrammes of rails in a few days; how many of them it took to do this is not stated. Further careful investigations into the origin, habits, etc., of this terrible worm are to be made.

We should prefer to see a few specimens of the "railoverous worm" before taking active measures to prevent its importation into this country. It is, perhaps, some relative of the "ice-bug," which is occasionally reported to be destroying the ice crop in this country, but of which the German entomologists do not seem to have heard.

The Naval War College.—The Naval War College will reassemble at Newport on the first Monday in September, and continue in session until late in December.

Commander Bainbridge-Hoff will give a digest of contemporary foreign opinions on the subject of naval tactics, both of single ships and of fleets. The tactics of the gun, of the ram, and of the torpedo, their best and most effective method of use, that is, in actual battle between opponents, or between contending fleets, will be separately treated, each by an officer who will aim at bringing out the strength of his weapon and the weaknesses of the other two. These will be followed by some lectures on grand tactics. The question of naval gunnery will be treated by Lieutenant John F. Meigs, whose lectures last year were particularly interesting and instructive. Professor Soley will give his lectures on international law. The subject of coast defenses will be discussed, as last year, by an army and a navy officer. General Abbot, of the Army, will aim at giving naval officers an insight and grasp of the general principles which guide the military engineer in planning and constructing the defenses of harbors. The question of sea-coast defenses will be exhaustively discussed from the naval point of view by Lieutenant C. G. Calkins, of the Naval Intelligence Office. The subjects of military strategy and tactics and of naval history will be treated by the same officers as last year. Assistant Naval Constructor Gatewood will lecture on the preservation and care of iron ships, and upon the injuries to which they are liable from grounding, collision, etc. Medical Director Dean will lecture on Naval Hygiene.

Lieutenant-Commander Stockton is now engaged upon an examination of the way in which the various nations of Europe are stationed in the Gulf of Mexico, the Caribbean and in the Pacific Ocean, with a view to determining the relative strategic value of these stations. It is intended that the study of the Gulf and Caribbean Sea, regarded as a great strategic field of special importance to the United States from its proximity, and above all, if any trans-isthmian canal shall be made, shall form a prominent part of the War College course. Mr. Stockton will bring together the facts of commerce and existing trade routes between the Western Pacific (Australia, China, etc.) and Europe; together with the modifications likely to follow upon the building of a canal.—*Army and Navy Register.*

New Consolidation Locomotives.—The Pennsylvania Company has recently completed, at its shops in Fort Wayne, Ind., some consolidation engines of a pattern known as Class S, These engines have cylinders 20 x 24 in. and four pairs of 50-in. drivers. The spread of the cylinders is 7 ft. and the total wheel-base of the engine is 21 ft. 6 in. The total weight of the engine in working order is 105,500 lbs., divided as follows: On truck, 11,250; first pair of drivers, 23,700; second pair of drivers, 21,750; third pair of drivers, 23,450; fourth pair of drivers, 25,300 lbs.

The boiler is of the straight-top pattern, with one dome; the barrel is 58½ in. diameter, and there are 157 tubes 13 ft. 3⅝ in. long. The fire-box is 7 ft. 11¾ in. long and 34⅜ in. wide inside. The grate area is 22.6 square feet, and the heating surface 1,361 square feet. The working pressure is 125 lbs. Crown-bars and bolts are used to support the crown-sheet, instead of long staybolts to the outside crown-sheet, this change having been made to facilitate the cleaning of the crown-sheet, which has to be done frequently on account of the impure water on the line.

These engines are equiped with the Westinghouse driver-brake and the Ross steel brake-shoe. U. S. metallic packing is used on piston rods and valve rods.

Two sizes of tenders are used with these engines. The first has a tank holding 3,000 gallons of water and 9,200 lbs. coal, and weighs 22,500 lbs. empty and 56,650 lbs. loaded. The larger tender carries 3,600 gallons of water and weighs 30,600 lbs. empty and 60,650 lbs. loaded.

These engines were designed to run freight trains which have heretofore been run by "double-headers"—that is, two locomotives coupled, each having 16 x 24 in. cylinders and 62-in. drivers. The Class S engines handle the same train as the two light engines with ease, and with a considerable saving in fuel and other expenses.

Recently comparative trial trips have been made over the Pittsburgh, Fort Wayne & Chicago road, between Fort Wayne and Chicago, by one of the Class S engines and the Strong locomotive *Duplex*, to test their relative economy in the consumption of fuel. The Strong engine has also been run on passenger trips on the same line. The result of these tests has not been announced.

THE RAILROAD AND

ENGINEERING

JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid $3 00
Subscription, per annum, Foreign Countries 3 50
Single copies 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery Avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, SEPTEMBER, 1887.

THE British Secretary of State for War has issued a memorandum to the effect that any official of the department, whether civil or military, holding stock in any firm or company which transacts business with the department is thereby disqualified from retaining his post.

If the above rule were applied to railroad officials in this country, there would be a great thinning out on some of our lines, especially in the higher ranks.

THE French Railroad Jubilee, about which a great deal was said some months ago, is a flat failure, if correspondents are to be believed. It was apparent that this would be the case when the great railroad companies of France refused their support. The fact is that no project of this kind can succeed in France without official support, and in this case it was altogether lacking. The reasons which led the railroad companies to refuse their support were sufficient and were fairly stated in a letter which was published at the time.

AN article on the use of electricity to increase adhesion and tractive power of motors, which is published in another column, indicates a line of investigation which may be productive of good results, although it is hardly likely that it will develop all that the author claims for it. His view of the question is, undoubtedly, far too sanguine; but there is enongh foundation for his claims to warrant further investigation.

In this connection it may be of some interest to note that experiments in the use of electricity for increasing adhesion were made on the Central Railroad of New Jersey nearly 30 years ago, about 1858 or 1859. Two freight engines on that road were fitted with batteries for the purpose of magnetizing the tires and so increasing the adhesion. The experiment was not long continued, however, and it does not appear that any good results were obtained; at any rate the use of the apparatus was not continued or extended. Possibly it was defective in its nature and very different from anything that would be applied now.

THE National Electric Light Association at its Boston meeting approved a bill which is to be presented to Congress at its next session, and which provides for the appointment of a commission to investigate the patent laws of this and other countries, and to report what changes seem to be needed in the present law.

That some changes are needed cannot be denied, and a properly constituted commission might do much toward the improvement of the patent laws. Its report might also well include a statement of such changes and additions as are needed to enable the Patent Office to dispose of its work with greater promptness than is now possible.

THE full extent and value of the iron-ore deposits of the Lake Superior have not been fully known or appreciated until recently. The Marquette and Menominee districts have, until within three years past, fully supplied the demand and were the only part of the region that was productive or even fully explored. Three years ago a company with abundant means began to work the extensive deposits known to exist around Vermillion Lake, some 70 miles north of Lake Superior in Minnesota, and about the same time others began to explore the Gogebic and Penokee ranges in Wisconsin, where iron ore was known to exist, although no one apparently had any definite idea of the extent or value of the deposits. These explorations and the building of new railroads through the region have resulted in an exceedingly rapid development of those ranges, where a large number of mines have already been opened and are making large shipments.

The peculiar character of the ores and the facilities for lake shipment with only a short railroad haul, making it possible to deliver ore to furnaces over a large extent of country at low rates of freight, give these deposits great value. The present indications are that they are of a nature that will permit of working for many years without exhaustion, so that a new and permanent source of supply has been secured.

THE New York meeting of the American Association for the Advancement of Science, a report of which will be found in another column, was a very successful one, whether it is considered from the point of attendance, of the variety of subjects considered or of the value of the papers presented. In so large a body and when so large a number of papers is presented some sifting process is always necessary; but at this meeting not many papers were rejected, and many of those read were of permanent value.

As was natural, much interest centered in Mr. Edison's paper, a brief abstract of which is given elsewhere. A large number were attracted by the papers on the Nicaragua Canal, and many others were interested in the papers and discussions in the Economic Section. As a whole the meeting was an excellent one; but it was unfortunately one of those which defy the limits of a necessarily condensed report.

One of the drawbacks of so large an association is that the necessary routine proceedings and the reading of papers occupy so much time as to leave far too little for

discussion. But discussion and conversation are or should be the best means of producing that mental friction and promoting the mutual acquaintance which are the chief benefits of such meetings as those of this association. Some way of giving increased time for discussion is very desirable. It would hardly be possible to lengthen the time of the meetings, and a limitation of the number of papers to be read in each section would probably be the easiest way.

NOWHERE has the old form of low-pressure beam-engine been more closely adhered to than in the numerous steamboats employed on the Hudson River and Long Island Sound. Substantially the same form of engine has been in use for many years, and the only changes made have been improvements in details and a slight increase in the working pressure carried in the boilers. Two notable exceptions are, however, to be made in two new boats of great size now building for the Stonington and the Fall River lines on Long Island Sound. In both of these boats higher boiler pressure and compound engines are to be introduced, and the approved modern practice in marine engineering will find place.

The Stonington Line boat is to have compound oscillating engine, acting directly on the main shaft; while in the steamer for the Fall River Line the beam engine will be adhered to, the compound principle and higher boiler pressure being adopted. Both will be paddle-wheel boats, and in both the feathering wheel will be adopted.

The continued adherence to the old type of engine is somewhat surprising, in view of the changes made elsewhere. The only exception to the rule heretofore has been in the building of two or three propellers of considerable size which have been for a year or two past in use on the lower Hudson, and which have proved themselves not only economical, but among the fastest boats on the river.

It is to be noted that the two new Sound boats mentioned above are to be of great size, approaching the larger ocean steamers in their dimensions and exceeding them in their passenger accomodations. For one of them, the ***Puritan*** for the Fall River Line, it is claimed that she will be the largest steamboat for inland waters in the world.

THE Navy Department is advancing quietly but steadily in the work of reconstructing the Navy on modern principles. Contracts for three new cruisers and two gunboats were let in August, and the plans for the new armored battle-ship and cruiser are nearly ready, so that contracts for those vessels will soon be let. Plans for the expenditure of the sum appropriated by Congress for floating batteries for harbor defense, are to be considered by a board of naval constructors and officers.

In the meantime the Department is evidently determined that vessels of old patterns and inferior construction shall not be retained any longer than is absolutely necessary. In this line are several recent decisions against repairing old vessels which would need the expenditure of considerable amounts to keep them longer in service.

In this connection it is well to note that it is not to be expected that an entirely new navy can be built and equipped without some mistakes. In England, where far more attention has been paid to fighting ships and ordnance, and where the naval expenditures are far greater than here, there is constant and severe criticism of new ships and guns, and there is abundant material for such criticism, not in mere differences of opinion, but in actual mistakes and blunders of the Admiralty and its officers.

Naval science is still largely experimental in its nature, and will necessarily continue to be so. At present we are in a state of transition, and it is impossible to say what may be the result.

AT present there seems to be, among the best English and European authorities, a tendency to return to the use of lighter and swifter vessels, and to argue that they will, after all, be of the greatest use in actual warfare. This is a reaction from the tendency of the past ten years to build armored vessels of enormous size and weight, carrying guns of corresponding size. These huge vessels have not done what was expected of them by their designers, and have proved in several cases unwieldy and hard to handle, while high speed was not expected of them.

It is now claimed that ships of this class, while exceedingly costly to build and operate, are also peculiarly open to attack from torpedo-boats. They are not adapted for cruising and are simply huge fighting machines, and in time of war it might be very difficult to put them where they were needed. In most of these ships everything has been sacrificed to fighting qualities, and now, it is charged, by their opponents, they cannot even fight.

There seems to be some reason in these arguments, although it is probable that they are carried to an extreme. The big armored ship has its place, but it is probably a very limited one, while the lighter vessel is capable of a variety of uses, is an excellent cruiser and may be, properly handled, a very efficient fighter.

THE friends of the Nicaragua Interoceanic Canal are making a strong effort to secure public favor for their project. Mr. Menocal, who has for years been prominent among the advocates of this line, says that the preliminary payment upon the concession has been made, and that actual work on the canal has been begun.

The arguments in favor of this line of connection between the Atlantic and Pacific Oceans are certainly strong ones. While the distance from ocean to ocean is nearly four times as great as at Panama, the actual length of canal to be excavated is no greater, and the work is, on the whole, less difficult. The work on the improvement of the San Juan River presents no obstacles which money and engineering skill cannot readily overcome, and for the whole route there is the great advantage of a climate which, though tropical, is very healthy in comparison with that of Panama. The chief objection urged against the Nicaragua route is the number of locks which will be required and the greater time which the increased length of river and canal navigation will require. The distance from ocean to ocean by this line will be about 170 miles.

Should both the Nicaragua and the Panama canals be built, it is very doubtful whether either would be a financial success. If all the commerce which is likely to seek the transit were concentrated in the Panama Canal, it is not by any means certain that interest could be paid on the enormous cost of that work, except by charging tolls so exhorbitant in amount that they would largely reduce the business. With two canals open the tolls

would be limited by competition, and the business would be divided. In such a contest the Nicaragua route would probably fare the best, on account of its lower first cost, and, if the claims of its advocates are correct, its much lower expenses of maintenance.

THE tests of steel to be used in the new warships will hereafeter be in charge of a board composed of Captain Phythian, Lieutenant Rodgers and Assistant Engineer Bryan, who have been detailed for that duty by the Secretary of the Navy. It is understood that this new appointment does not imply any important changes of method or any relaxation of the strictness of the tests; nor is it intended to cast any reflection on the previous conduct of the tests, which has been under the charge of Commander R. E. Evans, who is now assigned to duty on the Lighthouse Board.

THE CHATSWORTH ACCIDENT.

THE month of August was marked by a railroad accident more terrible in its destruction of life than any which has occurred in this country since the Ashtabula disaster in December, 1876. The facts are briefly as follows:

An excursion train over the Toledo, Peoria & Western road broke through a small wooden bridge near Chatsworth, Ill., which was on fire, and had been so far destroyed that its timbers could offer little or no support to the train; the accident occurred near midnight of August 10. The train consisted of two locomotives, three baggage cars, six ordinary passenger cars and six sleeping cars, and appears to have been running, on a down grade, at a speed of about 40 miles an hour. The first engine passed over, but the second one went into the ditch, and the three baggage and six passenger cars were piled on and around it in a complete wreck, so that, as an eyewitness says, three cars, or their wreck, did not occupy more than the length of a car. The wreck caught fire, but the fire was kept back by the exertions of the surviving passengers, and most of it was saved. The six sleeping cars escaped with slight damage.

The train carried some 750 passengers, and of these 85 were killed at once or fatally injured, while about 150 were less severely hurt.

The bridge itself was a small wooden pile or trestle affair over a little stream which was dry at the time. The weather had been very dry for some time, and, as a measure of precaution, the trackmen had been burning off the weeds and grass near the roadbed. It was at first reported that the fire had been purposely started, but the final decision of the coroner's jury was that the sectionmen had not been sufficiently careful in extinguishing their fires, and that the bridge probably caught fire from sparks remaining in the grass.

As nearly as could be ascertained, the engineer on the forward engine first saw the fire on the bridge when he was about 500 feet away. His engine was a freight engine and was not provided with air-brakes or with driver-brakes, and the air-brakes could only be put on from the second engine, whose driver, of course, had no outlook forward, and could only act on the signals he received.

Here, then, was a combination of several sources of danger. A heavy train was running at high speed over a road in poor condition; the train was insufficiently provided with brake-power; a wooden bridge had been thoroughly dried by long drought, and was in condition to take fire from a very small spark; and fires had been within a short time burning near the bridge. A combination of all these causes, apparently, was required to produce the accident.

The first and most obvious cause was the wooden bridge; and the immediate result of the accident has been a general outcry against wooden bridges of all kinds. Theoretically, of course, all bridges and crossings should be as solid as any other part of the roadbed, and stone or iron would be the only allowable material. Practically, in the present state of railroading in this country, this is not possible, and where stone is scarce, as on most of the prairie roads, wood must continue to be largely used, until increasing traffic and prosperity permit the substitution of a more durable and less destructible material, either stone, iron or steel. So far as strength is concerned, a wooden bridge of small size can be made sufficiently safe, and with proper care and watchfulness against fire it can carry any ordinary railroad traffic.

It is not intended by this to advocate the use of wood for permanent structures where a better material is possible. Undoubtedly, there are many wooden structures now in existence on roads which can afford to do better, and which ought not to be allowed to retain them; but for temporary use, and on new and struggling roads, the wooden bridge and culvert will continue in use for a long time to come and must be accepted as necessary.

The main cause of the disaster in this case was probably the lack of sufficient care in watching and guarding the road against just such a contingency as did arise. The coroner's decision put the blame on the section-foreman, as the nearest person in authority, but a more searching investigation may find either that he had not received proper orders, or that he had followed the example of others higher in authority in a general lax way of working, and that he founded his methods upon a general looseness of discipline, which may have existed on the line, as it does on too many others. In either case he was to blame, of course; but a considerable share of condemnation may well be shifted upon other shoulders.

The manner of running the train brings up again the vexed question of using "double-headers," about which there has been so much talk in time past. The practice is not in existence on many of the best managed roads, but there are still many superintendents who would consider it safer to run such a train with two locomotives than to run it two sections, holding that the danger of collision in the latter case would be greater than any arising from the use of the second locomotive. There may well be some doubt allowed where there is such a difference of opinion as on this point.

If the double-header question be passed over, there is still much fault to be found with the make-up of the train and with its running. The speed, if given correctly, was greater than should have been allowed under the circumstances. A train so loaded as was the one in question, especially on a road in poor condition, should have been kept well in hand, and should not have exceeded a moderate speed which would permit of a quick stop in case of danger. Had this been done, the accident might have been avoided. Again, had the first engine been provided with air-brakes, or even with driver-brakes

only, it would seem as if it might have been stopped in the 500 ft. after the fire was seen, or at any rate its speed might have been checked so far that the consequences of the derailment would have been very slight. But the engineer of the first engine could not put the brakes on the train, and the time required to give the signal, slight as it would have been, was enough to destroy the chance of escape which remained. In point of fact, there does not seem to have been any serious attempt to stop the train before the bridge was reached.

The fire which threatened the destruction of the wreck and of the injured may have caught from the bridge and may have come from the lamps in the cars. Fortunately there were no fires in the stoves, or the wreck might have been kindled so quickly that it would have been impossible to prevent its complete destruction and a terrible addition to the slaughter. Only the time of year prevented a frightful addition to the death-roll and another warning against the use of dangerous stoves and heaters.

In itself the accident was not of a very uncommon kind. Especially in the West and Southwest, where prairie fires are common and roads are generally worked with the smallest possible force, run-offs from burned bridges have been recorded more than once, to say nothing of the probably more numerous cases which were not heard of. Only the substitution of a crowded passenger train for the usual freight made the present accident one of the worst in the long and terrible list which marks the history of our railroads.

THE CYLINDER CAPACITY OF LOCOMOTIVES.

THE report which has been made on this subject by the Committee of the Master Mechanics' Association, which will be found on another page, is a very timely one, as too little attention has heretofore been given to the proportion of the cylinders to the other parts and to the weights of locomotives. The fact of the diversity of practice which exists, shows that there is a great deal of ignorance or misunderstanding of the subject somewhere, otherwise there would not be so much difference in the relative sizes of cylinders.

At first sight the subject seems a very simple one, and it appears as though all that need be done is to follow Mr. Webb's practice on the London & Northwestern Railroad, which, as he reported it to the Committee, is "to arrange the diameter of the cylinders so that the tractive power at starting, with full boiler pressure, does not exceed the adhesive power under the most favorable circumstances." This means that the cylinders should be made of such a size that we can always turn the wheels in starting. As the adhesion of a locomotive with dry sanded rails, as shown by Captain Galton's experiments, is as much as—perhaps a little over—one-third of the weight on the driving-wheels, we ought to produce a rotative effect on the wheels equal to this adhesion. The Committee take the maximum adhesion at one-fourth the weight on the driving-wheels, which appears to be too little, as cylinder capacity is needed to turn the wheels when the adhesion is at its maximum, that is with a perfectly dry rail and dry sand. The Committee also take the maximum effective cylinder pressure at 85 per cent. of the boiler pressure. Molesworth gives the effective pressure on the piston, when steam is cut off at three-quarters of the stroke, at 90, and indicator diagrams also show that at slow speeds as much as 90 per cent. of the boiler pressure is exerted on the pistons. For the purpose of illustration, we will take the indicator diagram shown in fig. 1, which was taken with a boiler pressure of 135 lbs. and gave an average pressure of 121.5. With 17 × 24 in. cylinders and 5½ ft. wheels, the tractive power from this diagram would be 12,800 lbs. if calculated in the usual way. The rule which is ordinarily used gives the *average* tractive force exerted. But the pressure on the crank pins at right angles to the crank, or the "rotative effect," as it is called, varies very considerably during each revolution of the wheel. In fig. 2 this is shown. The horizontal line $A\ E$ is supposed to represent the circumference of the driving-wheel, stretched out into a straight line. One of the cranks is supposed to be at its dead points at A C, and F, and the other at F and C.

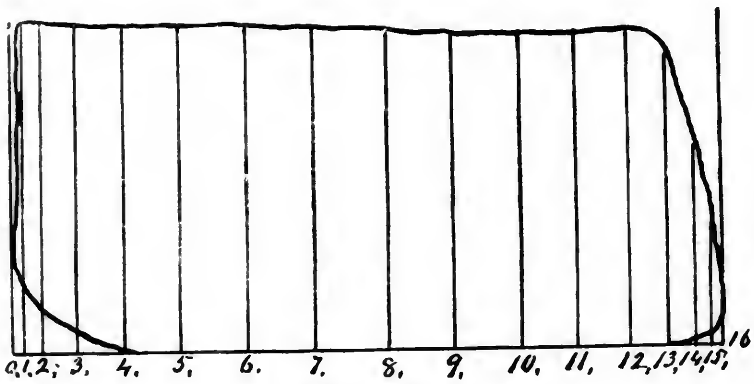


Fig. 1.

The rotative effect produced at the circumference of the wheel by the right-hand cylinder is represented by the vertical lines 1 *b*, 2 *c*, 3 *d*, 4 *e*, etc., through the lower extremities of which the curve $A\ F\ C\ G\ E$ is drawn, so that the distance of this curve from the line $A\ B\ C\ D\ E$ represents the tractive force exerted by one cylinder at the rail.* The

*** The method of drawing a diagram of this kind will not be described here, but those interested in the method of doing it will find it explained in a treatise on the Steam Engine by Arthur Rigg, published by Spon, and in another excellent and more recent book on the steam engine by George C. V. Holmes, published by Appletons**

horizontal lines and the figures on the left show the amount of this force in pounds. It will be seen that at the dead point *A* this cylinder produces no rotative effect, but it increases up to about the middle of the stroke at *B* and ceases again at the end of the stroke at *C*. This is repeated again while the piston is making its return stroke from *C* to *E*. The curve *A F C G E* shows the effect of the right-hand cylinder only. The left-hand piston is in the middle of the cylinder when the right-hand one begins its stroke at *A*. To show the effect of the pistons that of the left-hand one is laid off from the curve *A F C G E* on the vertical lines *A a'*, *b b'*, etc. A second curve *a' b' c' d' e'* is then drawn through the lower extremities of these lines. This curve will represent the tractive force or rotative effect, exerted at the circumference of the wheels *by the two cylinders*, because, as will be seen, the effect of the one cylinder is added to that of the other. At *F*, when the left-hand crank is at its dead point, the curves coincide, and so again at *G*, as at these points the left-hand piston produces no effect. It will be seen, though, that at *e' f' g'* and *h'*, when the cranks stand at an angle of 45°, the rotative effect is considerably greater than at the intermediate points. What is also notable is that the

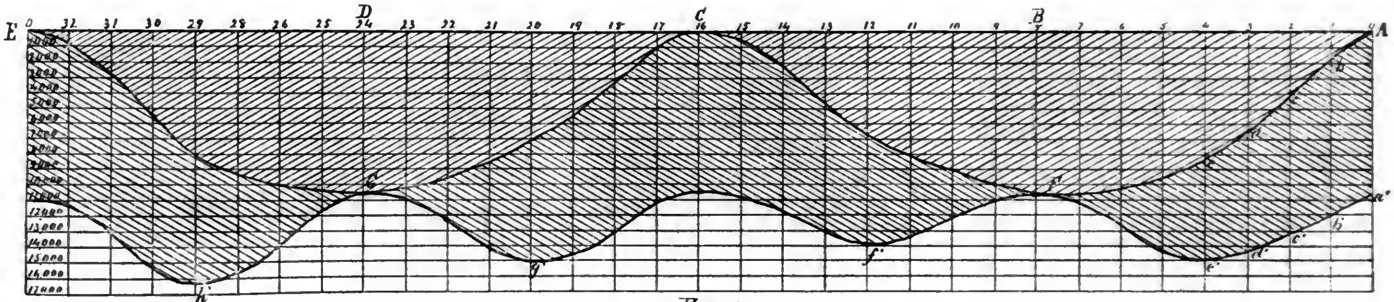


Fig. 2.

effect at *h'* is considerably greater than at any of the other points. The fact that a locomotive will start a greater load at one point in a revolution, has been noticed by locomotive runners and has often been denied by theorists. The practical men in this case were right.

The special point to which attention is directed is the great inequality of the rotative effect, or the tractive force, which is exerted by the pistons at the circumference of the driving-wheels. The calculation by the usual rule gives the *mean* tractive force, which is 12,800 lbs.; whereas, in the case illustrated, it varies from about 10,500 up to 16,500 lbs. during each revolution. If we assume the weight on the driving-wheels to be 50,000 lbs., and their adhesion equal to one-third the weight they bear, then the maximum tractive force would be just about equal to the adhesion, which would be 16,666 lbs. Of course, the tractive force should never exceed the adhesion, or the wheels will slip; nevertheless, it is important that we should always be able to turn the wheels under conditions which give the maximum adhesion. The fact, though, that the tractive power varies so materially during each revolution has not, thus far, been taken into account in calculating cylinder capacity. It would seem as though a proper basis for calculating cylinder capacity would be to take the adhesion at one-third the weight on the driving-wheels, and the average cylinder pressure at 85 or 90 per cent. of the boiler pressure, and then make the mean tractive capacity of the cylinders equal to three-quarters the adhesion of the wheels. As ¾ of ⅓ is ¼ these considerations lead to the same result as that reached by the Committee, although by a somewhat different method. There does not seem to be any very good reason, though, for adopting different co-efficients for adhesion for different classes of engines, because they all have occasion at times to use their maximum adhesion on dry, sanded rails, and if there is then not sufficient cylinder capacity the maximum load which the engine can draw will be diminished. It, therefore, would seem as though it would be best to assume one-quarter the weight on the driving-wheels as the adhesion of all classes of engines.

The problem which usually presents itself is to get the area of piston for a given stroke, diameter of cylinder and weight on driving-wheels. The formula of the Committee is not given in a convenient form for this calculation. If we take the formula for calculating the tractive power of locomotives:

$$\frac{A \times p \times 4\,S}{C} = \text{Tractive Power} = \frac{W}{4} \text{ in which}$$

A = Area of the piston in square inches.
p = Mean pressure in cylinders.
S = Stroke of piston.
C = Circumference of driving-wheels.
W = Weight on driving-wheels—the stroke and circumference being both expressed in feet or inches.

Then, as the tractive power should be equal to one-fourth the weight on driving-wheels, and the pressure in the cylinder 85 per cent. of the boiler pressure, which will be represented by P, then

$$\frac{A \times .85\,P \times 4\,S}{C} = \tfrac{1}{4}\,W$$

from which we have:

$$A = \frac{\tfrac{1}{4}\,W \times C}{.85\,P \times 4\,S}$$

Or expressed arithmetically to get the area of the pistons for a locomotive:

Multiply one-fourth the whole weight (in pounds) on the driving-wheels by the circumference of these wheels, when the tires are half worn out. Then multiply 85 per cent. of the boiler pressure (in lbs. per square inch) by four times the stroke of the piston, and divide the first product by the second. The quotient will be the area of each piston in square inches.

The circumference of the wheels must be expressed in the same units as the stroke of the pistons. That is, they must both be in feet or both in inches.

NEW PUBLICATIONS.

RECENT NAVAL PROGRESS: June, 1887. Navy Department, Bureau of Navigation; issued by the Office of Naval Intelligence.

As all naval matters have been for several years in a transition state, and as our own Navy in particular has just begun to assume an entirely new form, information on naval matters is now of special interest and importance. Such information, however, is not always easy to get at, much of it being hidden away in the proceedings of societies and in technical journals, where it is difficult to find it when wanted. The Navy Department has realized this fact and has made an excellent attempt at supplying the need in its "General Information Series," of which No. VI has just been issued.

While this volume is, of course, designed mainly for the use of naval officers, it has in it much that is of value to engineers, and indeed to all who take an intelligent interest in naval progress, as will be seen from the brief list of the contents given below.

Chapter I is a sketch of the development of the torpedo, with descriptions of the latest forms of these weapons.

Chapter II is an account of the development of electric lighting on United States vessels.

Chapter III is on forced draft in marine boilers, describing the various systems in use both on naval and merchant vessels. In compiling this chapter the latest sources of information have been drawn upon.

Chapter IV is a description of the design, construction and trial of the 8-in. breech-loading rifled gun, the first high-power steel gun of large caliber completed in this country.

Chapter V is a general account of the changes in naval guns during the last 25 years.

Chapter VI is an account of recent progress in small arms, with a description of the leading forms of magazine rifles now in use.

Chapter VII contains a synopsis of the musketry instructions in the United States and foreign forces.

Chapter VIII is a reproduction of a paper on the much discussed question of belted and internal armor for warships.

Chapter IX is an analytical description of the French and English naval manœuvres of last year.

Chapter X gives the results of the great competitive trials of anchors at Portsmouth, England.

The volume concludes with a number of short notes on progress made during the year in design and construction of vessels and their equipment, armament and machinery; and on many other points in connection with naval management and similar matters.

The contents of the present volume have been well selected and carefully edited. The Navy Department has made an addition to naval literature, whose value is quite sufficient excuse for its existence.

BOOKS RECEIVED.

REVISTA MENSAL DE ENGENHARIA E INDUSTRIA: ABRIL, MAIO E JUNHO. Rio de Janeiro, Brazil; published by the Club de Engenharia.

PROCEEDINGS OF THE UNITED STATES NAVAL INSTITUTE: VOLUME XIII, NUMBER 3. Annapolis, Md.; published by the Institute. The present number contains papers on the Naval Brigade (prize essay for 1887); Training of Enlisted Men of the Engineers' Force; Iron and Steel and the Mitis Process; New Method of Carrying and Lowering and Detaching Boats, with a Suggestion for Defending Ships against Auto-mobile Torpedoes; Notes on the Literature of Explosives and on Electric Motors. The authors are Lieutenant C. T. Hutchins, U. S. N.; Passed Assistant Engineer W. M. Parks, U. S. N.; W. E. Durfee; Lieutenant D. H. Mahan, U. S. N.; Professor Charles E. Munroe and F. J. Sprague.

WATER SUPPLY IN THE CAPE COLONY: BY JOHN GEORGE GAMBLE. London, England; published by the Institution of Civil Engineers.

THE INTERSTATE COMMERCE ACT: A DISCUSSION OF THE PROVISIONS OF THE SECOND AND FOURTH SECTIONS. BY JOSEPH NIMMO, JR. Reprinted from *Frank Leslie's Illustrated Newspaper.*

THE IDEAL MODERN SCHOLARSHIP: BY HENRY SHALER WILLIAMS, PROFESSOR OF GEOLOGY, CORNELL UNIVERSITY, Ithaca, N. Y. This is a presidential address delivered by Professor Williams at the inauguration of the Alpha Chapter of the Sigma Xi Society at Cornell University.

THE MANUFACTURE OF SALT NEAR MIDDLESBROUGH: BY SIR LOWTHIAN BELL. London; published by the Institution of Civil Engineers.

THE CONVERSION OF TIMBER BY CIRCULAR SAWS AND BAND SAWS IN THE PINE-GROWING DISTRICTS OF THE UNITED STATES: BY LEWIS HENRY RANSOME. London; published by the Institution of Civil Engineers.

WATER SUPPLY FROM WELLS: PAPERS AND DISCUSSIONS. London; published by the Institution of Civil Engineers.

UNITED STATES GEOLOGICAL SURVEY: BULLETINS 34, 35, 36, 37, 38 AND 39. Washington; Government Printing Office.

SIXTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY: J. W. POWELL, DIRECTOR Washington; Government Printing Office.

ENGLISH AND AMERICAN RAILROADS COMPARED: BY EDWARD BATES DORSEY, C. E. New York; John Wiley & Sons. This is a reprint of Mr. Dorsey's paper read before the American Society of Civil Engineers; the book also contains the discussion on the paper by Messrs. W. W. Evans, Thomas C. Clarke and Edward P. North.

A TREATISE ON CABLE OR ROPE TRACTION AS APPLIED TO THE WORKING OF STREET AND OTHER RAILWAYS: BY J. BUCKNALL SMITH. C. E. London; *Engineering*, and New York; John Wiley & Sons.

THE NATIONAL CAR & LOCOMOTIVE BUILDER SUPPLEMENT: JUNE, 1887. New York.

OBITUARY.

J. B. CLOUGH, Assistant Chief Engineer of the Northern Pacific Railroad, died in Helena, Montana, August 22. He had been for some time in the service of the road.

MR. R. O. CARSCADIN died at his home in Trenton, Mo., July 25. He had been connected with the Chicago, Rock Island & Pacific road for many years, and Master Mechanic of the Southwestern Division of that road for 15 years past. He had been an active member of the Master Mechanics' Association for over 10 years.

DR. E. D. STANDIFORD died in Louisville, Ky., July 26, aged 56 years. He was a man of large wealth and had been connected with many railroad and other enterprises. He was President of the Louisville & Jeffersonville Bridge Company and was at one time for several years President of the Louisville & Nashville Railroad Company. He was a very active and energetic man and was better known as a financier than as a railroad manager.

WILLIAM C. MORRILL, of Atlanta, Ga., died in Boston, August 23, while on a visit to that city on business. Mr. Morrill had been for a number of years connected with the Western & Atlantic road, and for some years past Vice-President of that company. He also owned and controlled some large tracts of coal and iron lands in Georgia and Alabama, and was actively engaged in developing them.

ARCHIBALD CAMPBELL, who died in Washington, July 27, age 76 years, was a graduate of West Point and served in the Army till 1840. He was then engaged in surveys of western rivers for several years. He was afterwards, for four years, Chief Clerk of the War Department. In 1856, he represented the United States in the commission which laid out the northern boundary line from the summit of the Rocky Mountains to the Pacific Ocean, and in 1875 he served on the commission which completed the line from the Rocky Mountains to the Lake-of-the-Woods.

WILLIAM BAILEY LANG, one of the oldest of New York iron merchants, died at his home in Scarsdale, N. Y., August 5. He was 87 years old and was well known in the iron trade, having been virtually the life-long agent of the Lowmoor Iron Company, and for Charles Cammell & Co., Limited, of Sheffield, England. His office was at No. 50 Beekman Street. He retired from business in April, 1886. Mr. Lang was a prominent iron merchant in Boston nearly 50 years ago, when he came to New York. Afterward he established the firm of William Bailey Lang & Co., his partners being his sons-in-law, George M. Wheeler and Adams Bailey. The firm did a successful business as agents and importers. In 1877, misfortune overtook Mr. Lang and he made an assignment, but subsequently recovered much of his business prosperity.

WILLIAM BARBER BUDDICOME, who died at his residence in Flintshire, Wales, early in August, was born in Liverpool, England, in 1816. He served an apprenticeship in his native town, and when 20 years old, secured a position as Resident Engineer on the Manchester & Liverpool Railway. Subsequently he was Engineer on the old Glasgow, Greenock & Paisley line, and then Locomotive Superintendent of the Grand Junction Railroad. In 1841, he went to France to take charge of the rolling stock of the railroad then under construction from Paris to Rouen, and remained in that position until 1860. He was then, for a few years, engaged in some important contracts in France and Italy, including the Bellegarde Tunnel and a part of the Mt. Cenis road. About 1865, he retired from business and settled down in his native country. His services in France procured him the decoration of a Chevalier of the Legion d'Honneur. He was a member or the British Institution of Mechanical Engineers and the Institution of Civil Engineers, and also of the French Société des Ingénieurs Civils.

JOHN N. RISDON, for many years principal proprietor of the great iron works in San Francisco which still bear his name, died at Oakland, Cal., July 31, of paralysis, aged 69 years. He left the East in time to arrive in California in 1848 or 1849, but, crossing the Isthmus of Panama, he thought he saw an unusual opportunity for a mercantile venture, and opened a store at Panama. He remained on the Isthmus for nearly two years, then went to San Francisco. He was more attracted by business in San Francisco than by the mines, whither nearly all emigrants were flocking, and joined with John Snow in conducting small iron works. Later, he organized a corporation to construct and operate a foundry. He was the principal owner of the stock and President of the company, which was called the Risdon Iron Works Company. The enterprise was successful, and Mr. Risdon became a man of great wealth. In 1856, he was a member of the Vigilance Committee. Several years ago he sustained heavy losses, withdrew from the foundry, and since then has lived in retirement.

THOMAS T. WIERMAN, SR., died at his residence in Harrisburg, Pa., August 3, aged 74 years. He was born in Adams County, Pa., and learned surveying when still a boy. His first service as civil engineer was on the original construction of the Pennsylvania Railroad, and subsequently on the construction of the North Branch Canal, from Pittston to the State line of New York. He afterward constructed, as Chief Engineer, the Chemung Canal, which connected the water improvements of Pennsylvania with the New York State canals. After that he had charge of the building of the Barclay Railroad, running from Towanda, Bradford County, Pa., to the bituminous coal fields in that county. He also made the original surveys for the Brooklyn Water Works. Mr. Wierman took charge of the Pennsylvania Canal about the year 1857, being stationed at Huntingdon. In 1859, he removed to Harrisburg and continued in charge of that canal as Chief Engineer until his death. Mr. Wierman married Miss Piolett, of Bradford County, Pa., who survives him. He leaves two sons, both engineers, and three daughters, Mrs. S. S. Mitchell, of Buffalo, N. Y., Mrs. T. M. Ely, of Altoona, Pa., and Miss Sallie Wierman.

HORACE ABBOTT, one of the oldest and best-known iron manufacturers in the country, died August 8, at his residence in Baltimore, aged 81 years. He was born in Sudbury, Mass., and learned there the trade of a blacksmith, but soon extended his operations. He went to Baltimore in 1836 and soon afterward bought the Canton Iron Works from the late Peter Cooper. These works were gradually extended until they ranked among the largest in the country, and were known as the Abbott Iron Works. In these works were made the first large steamship shaft of wrought-iron in this country. It was for the Russian frigate *General Admiral* built for Nicholas I., in New York. It weighed 26,000 lbs. and aroused great interest when placed on public exhibition in New York. A great achievement of the Abbott Works during the war was in supplying the Government with 250,000 lbs. of rolled iron in 48 hours after receiving the order. They supplied Mr. Ericsson with the plates for armor of the *Monitor* and also supplied the plates for nearly all the vessels of that class built on the Atlantic Coast. Mr. Abbott retired from active conduct of business some years ago, and the works were operated by the Abbott Iron Company. They have been closed for some time, owing to the advantages which position and cheaper fuel have given to the iron makers in Pennsylvania and elsewhere in the close competition of later days.

Mr. Abbott was highly esteemed by his friends and business associates, and was a man of standing and influence in Baltimore.

PROFESSOR SPENCER F. BAIRD, Head of the Smithsonian Institution and of the United States Fish Commission, died August 19, at Wood's Holl, Mass., where he had been sick for some time.

Spencer Fullerton Baird was of mixed Scotch, English and German descent. His ancestors were preachers, surveyors, bankers and lawyers of New Jersey and Pennsylvania. His father was a lawyer of Reading, Pa. He is described as a man of high culture and close observation and an ardent lover of outdoor pursuits. His sons inherited his tastes.

At the age of 14, Spencer Baird, with his elder brother William, commenced a collection of game birds found in Cumberland County, Pa., which afterward was made the nucleus of the present magnificent Smithsonian Museum. The brothers contributed papers to the Philadelphia Academy of Sciences, which received marked attention, and soon afterward the great ornithologist, Audubon, became interested in Spencer Baird, and established a friendship with him which continued until Audubon's death and did much to shape the future career of his gifted protégé. Audubon presented him with a large part of his collection of birds, and young Baird in return contributed many facts and specimens to aid in the production of Audubon's works.

Professor Baird graduated from Dickinson College, at Carlisle, Pa., at the age of 17, and subsequently studied medicine in New York, although he never followed that profession. In 1845, when he was 22 years old, he was elected Professor of Natural History of the college at which he had graduated. Two years later he became associated with the distinguished Agassiz, and projected with him a work on the fresh-water fishes of the United States, which was never completed. During all this period it was his habit to make extended pedestrian tours for the purpose of extending his knowledge and enlarging his natural history collections. So great were his powers of physical endurance, that he had been known to cover nearly 60 miles on foot in one day between sunrise and rest.

In 1850, Professor Baird was elected Assistant Secretary of the Smithsonian Institution, with which his name and fame have since been indissolubly connected. On the death of Professor Henry he became the head of the Institution. In 1871, he was appointed, by President Grant, United States Commissioner of Fisheries, an office which added largely to his responsibilities and nothing to his compensation. The services he rendered in this capacity in increasing the food supply of the world would alone justify a national monument to his memory.

But Professor Baird's history is the history of the sysmatic zoology of the United States. A chronological catalogue of his works, prepared by order of the Smithsonian Institution and only carried down to 1882, includes over 1,000 titles. His services to science and natural history were rewarded by medals from the Acclimatization Societies of Australia, France and Germany. He was a member of the leading scientific associations of England, Austria, France, Germany, Holland, Portugal and New Zealand. Over 33 distinct genera and species in North, South and Central America and the West Indies have been named in his honor.

The extent of Professor Baird's labors and the practical service he has rendered as head of the Smithsonian Institution cannot be overstated. It is a melancholy fact that his last hours were embittered, and, according to the testimony of Professor Goode, his assistant, and other associates, his life was perceptibly shortened by causeless imputation cast upon his administration of the large fund placed at his disposal as head of the Fishery Commission. There never was the slightest foundation for those charges. They were investigated by the Appropriation Committee and found to be absolutely baseless, and the appropriation was continued without change. But the unjust suspicion struck home to Professor Baird's sensitive mind, and, with a brain and constitution enfeebled by incessant and long-continued overwork, hastened his death.

ALVAN CLARK, the founder of the great telescope works at Cambridge, Mass., died at his home in that city August 19.

Born in Ashfield, Mass., March 8, 1804, of parents who came from the Cape, and who traced their pedigree back to the early voyagers in the *Mayflower*, Mr. Clark was essentially a New England man. All the technical education he ever got he received in the public schools. At an early age, however, he showed a taste both for engraving and painting, and in his early manhood earned his living as a calico engraver at the Merrimac Works at Lowell, and elsewhere.

When he was 22 years of age Mr. Clark married. He still kept up his painting, and in 1835 gave up engraving entirely, and, removing to Boston, opened a studio on Tremont Street, making his home on Prospect Street in Cambridge. Here for 20 years he worked successfully as a portrait painter.

Mr. Clark was over 40 years of age when he became interested in telescope making. He had delighted in studying that scientific instrument during his leisure hours, and although he possessed no mathematical education, yet he was thoroughly conversant with optical principles. It is said that one day while he was watching his son make a metal reflector it occurred to him that he might be successful in the grinding of lenses, and, acting upon that idea, he soon produced object glasses equal in quality to any made. That determined his after life, for, giving up everything else, he, with his sons, began in 1846 the mauufacture of telescopes. Since then he had been unrivaled in his specialty of figuring object glasses.

Just before the war, Mr. Clark undertook the preparation of a glass 18 in. in diameter, 3 in. larger than any ever before made. That glass, which went to Chicago, revealed 20 stars in the nebula of Orion which had never before reached telescopic vision. It was with this instrument that Mr. Alvan G. Clark, Mr. Clark's son, in 1862, discovered the companion of Sirius. receiving the award of the Lalande medal from the French Academy of Science.

The present works of the firm were built in 1860. The Rev. W. R. Dawes, one of the leading amateur astronomers of England, has the credit of first bringing Mr. Clark's work into notice abroad. The number of instruments he made is very large. His cheapest one cost $300, while the national telescope he sold for $46,000, and the cost of the Lick glass was set at $50,000, without the mounting. A telescope of similar caliber to the national one was constructed for L. J. McCormick, of Chicago. The objectives alone to these instruments were worth $25,000 each, and were capable of a magnifying power of 2,000 diameters, and of increasing the surface of the object viewed to 2,500,000 times its natural size. This was the work of a man who had never seen a lens in process of construction in the hands of any one out of his own shop. The work necessary for the construction of such glasses may be conceived when it is understood that to make a good 4-in. objective a month's constant labor is required, while for an 8 or 10-in. objective a year is necessary.

But the triumph over these glasses was eclipsed by the subsequent work of the same firm on the telescope made for the Russian Government, and that which has been designed for the Lick Observatory in California. In 1870, the Russian Government contracted for an enormous telescope for the observatory at Pulkowa, and in 1883 the instrument was completed. The telescope was then the largest in existence. costing $33,000, having a clear aperture of 30 in., a 45-ft. focus, and weighing in the iron cell 418 lbs. It possessed a magnifying power of 2,000 diameters and was 7 in. longer in diameter than the instrument at Princeton Observatory, a few inches larger than the Washington telescope, both made by Alvan Clark & Sons. From the Imperial Academy of Science came a vote of thanks, and from the Emperor of Russia a gold medal.

The largest telescope in the world was to be eclipsed by a larger still, and to this end the firm undertook, a few years ago, the construction of a 36-in. object glass for the Lick Observatory. But an accident during an experiment about a year ago destroyed the photographic lens for this glass, and at the present time Mr. Alvan G. Clark is in Paris negotiating for another lens to take its place.

Mr. Clark was married on March 26, 1826, to Miss Maria Pease, of Conway, and they celebrated the sixtieth anniversary of the wedding last year. Mr. Clark's extraordinary power seemed to be acuteness of the eye, of the touch, and, finally, of the understanding, combined with unlimited patience. His manners were free and open, and his speech dignified. He had received honors from three colleges—Amherst in 1854, Princeton in 1865, Harvard in 1874. Mr. Clark leaves a widow and two sons—Alvan G. and George B. Clark.

Contributions.

Old Valve Motions.

To the Editor of the Railroad and Engineering Journal:

I HAVE read with pleasure several articles in your JOURNAL, and among them in particular that number of "The Rogers Locomotive Works" which treats of the valve motions used in former times. Mr. William Swinburne was the father of them, and the writer well remembers the different devices for locomotives and the trials to compete with the Bush Hill Works and the Baldwin Works of Philadelphia. If George Hollingsworth is alive in Paterson he could unfold a history of the Rogers trials on different roads in the years I speak of.

I see you speak of the Allen valve and link as constructed in 1873. I would like to know how it was given the name of "Allen." I saw the link, but not perfected as of late years, on the engines *Erin* and *Scotia*, built by Mr. Richard Eaton at Hamilton, Canada, in 1860. Also, I had charge of shops in Columbus, Ohio, and built several there in 1863, followed by Mr. Robert Curtis, the present Master Mechanic, who constructed No. 25 for that road in 1865. Since those dates I have used the same link and have with me the identical diary of 1864 with a full account of it, and also of Mr. William Romon's adopting it and applying it to the *Economy*, a locomotive placed in one end of a passenger coach. Again, I have with me the identical model I used in Columbus, O., in the winter of 1863-64 in constructing the straight-link motion, and I have built here on this island a locomotive from the same model of valve motion I used at Columbus in 1863-64. I have also a Mogul engine and do not bend or crook anything to get the link or radius-rod in, as I use a U rocker-shaft, both arms being elevated or turned upward, one connecting with the valve-rod; the valves are piston valves. The other arm connects with the link, and the rods run direct to the eccentrics on an angle above the line of the cylinders to clear the forward axle. The rocker-box is placed on the lower cylinder brace and in front of the forward drivers. The valve-rod slides in a box above the flat guides, secured to the guide-yoke, with valve connection extending back toward the cab, and couples to a pin attached to the rod. The valve-rod is ⅞ in. and the piston valve is 5 in. diameter; the steam-chest is around the cylinder, instead of on top. The valve can be opened at either end of the cylinder, and is my patent, with an improvement whereby I get rid of compression and vacuum and thus obtain the best results.

A flat valve when traveling or in motion lifts from the seat, if steam is not used, at each end of the stroke of the piston; this is caused by compression in the cylinder and vacuum in the steam-delivery pipe. This I do away with, as I have proved upon the locomotive just built for this company.

I worked for the Rogers Locomotive Works in 1844, 1845 and 1846, and I well remember the length of time consumed in constructing a locomotive; also nearly every man who was then employed there—many being scattered in after years. I was in the employ of the Schenectady Locomotive Works in Norris' time, before Walter McQueen was there and also after he came. I took from those works the first locomotive that ever went west of Lake Michigan; at the same time Peter and Jack Ebberts, of the Galena & Chicago Union, took up an old engine called the *Whittlesey*. I also worked for David H. Biggs on the old Syracuse & Utica Railroad (now part of the New York Central), while David Matthews had charge at Schenectady before J. Blackburn took charge there—and I well remember his "hump-back" smoke-stacks. Those were the days of railroad infancy. I also took from Schenectady the first engines for the Great Western Railway of Canada—called No. 1 *Hercules* and No. 2 *Sampson*—and many others, and through Mr. McQueen's advice I remained there many years as a locomotive engineer. On January 17, 1853, I ran the *Sampson* on the opening train, or excursion for the opening of the whole road; John T. Clark, Chief Engineer, and his associates—William Scott, Norman Booth, Charles Henson and William Bowman—were on the engine with me from London to Windsor.

I could tell a great deal more, but cannot get it into this letter.

WALTER S. PHELPS.

FERRO-CARRIL DE GUANTANAMO, CUBA.

[NOTE.—The Allen straight link, which is an entirely distinct thing from the Allen *valve*, the two having no connection, was, we believe, first used, or at least first described, in 1855 or 1856, several years before the time named by Mr. Phelps, in his interesting letter of historical reminiscences. The Allen valve was used at the Rogers Works at the time stated in the book.—EDITOR.]

THE MILLER PLATFORM AND COUPLER PATENTS.

(Continued from page 255.)

THE next matter to be considered is the 1863 patent of Miller, both in its relation to the state of the art and as it bears upon the Janney coupling. The only claim of this patent which was pressed was the fourth, which is as follows: "The double beveled hooks *C C'*, disconnected from any coupling or bumper box constructed, arranged, and operated in the manner described."

Fig. 1 is a copy of a drawing taken from the Miller patent. The view is an inverted plan of the bottom of the car.

In this cut, the two hooks are shown fastened to their respective car beds *A A'*, and the double bevel of each hook is marked respectively *a* and *a'*, the letter *a* designating the inner bevel and the letter *a'* the outer bevel.

To keep the hooks *C C'* in their locked position after coupling, spring gates were used, which are marked *F*, one form being shown upon car *A* and another form upon car *A'*. With these gates, however, we have nothing to do.

It will be observed that no buffers of any kind are shown, and that the cars are close together, the ends of the car-beds almost meeting. The hooks *C* and *C'* cannot act as buffers, and, were it not for the meeting of the ends of the cars, they could approach each other to any extent as far as the couplings were concerned, these not opposing any resistance to the movement toward each other of the cars themselves.

It is difficult to state briefly the exact view taken by the complainants of the claim in controversy.

They held that the hook was to be independent of a coupling or bumper-box, though means of receiving the

shock when the cars met were to be present or might be present. They admitted that the Janney hook had not the bevel marked at *a'* (the outer bevel), but appeared to think that the inner bevel *a* was present.

The functions of the bevels are to separate the hooks laterally when the cars *A* and *A'* are forced together, and

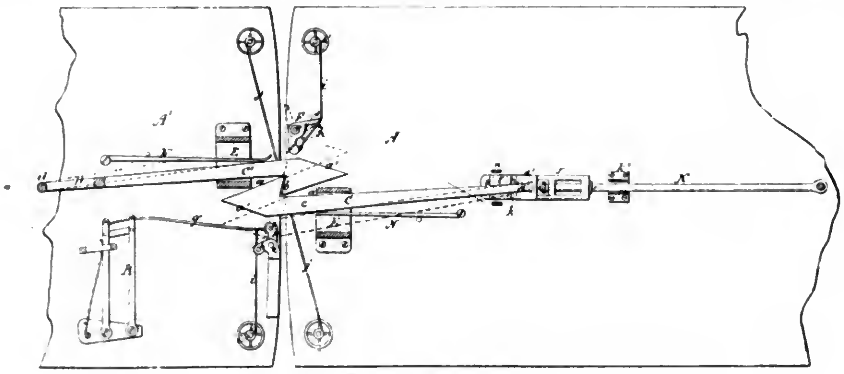


Fig. 1.

BOTTOM VIEW, MILLER'S PATENT, 1863.

the functions of the bevels *a'* are to open gradually the gates *F*. Now, according to the complainants, as the Janney hooks had no gates, they required no bevel *a'*, and therefore the claim might be read as requiring but a single bevel when such alleged equivalent devices were

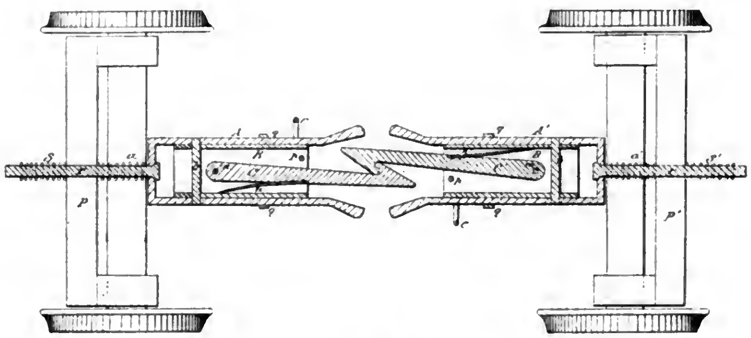


Fig. 2.

JOSEPH MILLER'S COUPLING, 1854.

used. The view taken cannot be made clear here, for it was not clear at the time of the trial or since. On reading over the testimony, months afterward, the matter is not any clearer. However, without going into a careful review of the complainants' position in this matter, it will be best to refer at once to the state of the art and see just where Miller stood.

It is not deemed necessary to go into a detailed description of the Miller device as above shown, for, from the drawing, it will be evident to those readers who are mechanics precisely how the parts operated. The windlass for opening the hooks and the like mechanism for opening the gates is clearly shown and needs no explanation.

Among the earlier patents, the first which is worthy of notice is the patent of Joseph Miller, No. 11,940, dated Nov. 14. 1854.

This earlier Miller (who we believe was a cousin of Ezra Miller, the inventor we are speaking of) showed two hooks with a single bevel, but each pivoted in a bumper-box of old and well-known construction. The hooks were sepaated not by a sidewise motion as in the 1863 Miller patent, but by an up-and-down movement. Fig. 2 is taken from the 1854 patent of Miller, showing the parts partly in section.

This patent, the defendant contended, showed a single beveled hook and a bumper-box.

The next patent to be referred to is that of J. H. Jones, No. 12,680, dated April 10, 1855.

This patent showed two hooks held together by springs, and the specification indicates that these hooks can be used with or without bumper-boxes, though this is not exactly definite. Fig. 3 is a cut taken from the patent of Jones.

It will be seen that the hooks *C C* were provided with a bevel to separate them when the cars came together, and that they were forced to couple and remain coupled by the springs *D D*. If no buffers or bumper-boxes were used, then the two ends of each hook would strike the

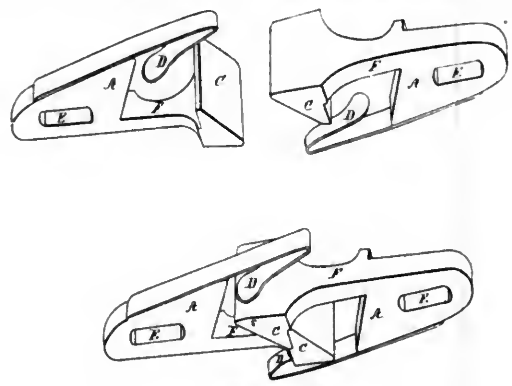


Fig. 3.

JONES' COUPLER, 1855.

cavity in the opposing hook, and a buffer would be thus formed.

The patent of E. L. Keeler, No. 24,938, dated Aug. 2, 1859, showed two hooks disconnected from any coupling or bumper-box. The hooks were separated by rotating

them. Fig. 4 is an engraving of the hooks taken from the patent.

Fig. 4.
E. L. KEELER'S PATENT, 1859.

The patent of L. Adams, No. 26,403, dated Dec. 13, 1859, is illustrated in the accompanying cut, a bottom view being shown.

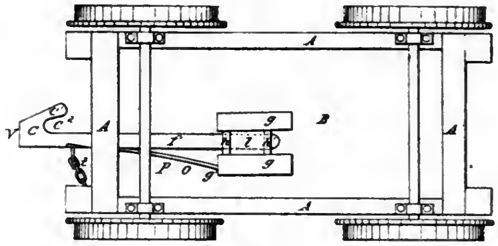


Fig. 5.
L. ADAMS' PATENT, 1859.

This patent, clearly and without doubt, shows a single beveled hook attached, as is Miller's, to a spring (as shown in the cut), and not connected with a coupler or buffer-box.

The drawing of the patent does not show the hook C as projecting quite far enough beyond the beam A, but this is probably a draftsman's error. Had this hook had another bevel it would in terms have met Miller's claim.

The patent of Birch & Noble showed two hooks connected with a coupling or buffer-box, the hooks working vertically; this patent was issued in 1862.

The hooks were double beveled, and one or the other might be uppermost in coupling. Each hook had two draw-faces.

The next patent of importance is that of M. Waterbury, No. 34,384, dated Feb. 11, 1862.

The accompanying cut (fig, 6) shows the mechanism.

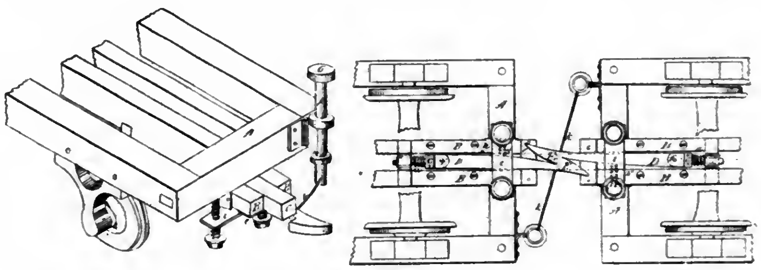


Fig. 6.
WATERBURY'S COUPLER, 1862.

In this structure a single beveled hook is shown, pivoted to a bumper-beam. The hooks are lettered E E, and the bumper is lettered C. The bumper-beam slides between the beams B B.

During the trial, it was suggested that Miller was the first to couple the cars closely together so that people would not fall between them, but this was shown not to be so by reference to the patent of C. Waterbury, No. 9,084, dated Jan. 29, 1852.

A view of the structure (fig. 7) is given; taken from the patent. The cut shows a top view in section of the ends of two cars.

In this device the blocks B B are elastic, and the platforms are enclosed, having doors leading to the steps. The coupling was of an old form having a buffing-box, but instead of a link, a coupling-bar was used having a hole at either end. The coupling or buffing-box itself was provided with springs. The patent recognized the advantages of close coupling and pointed out the safety to passengers which would follow from such a construction and arrangement of the parts.

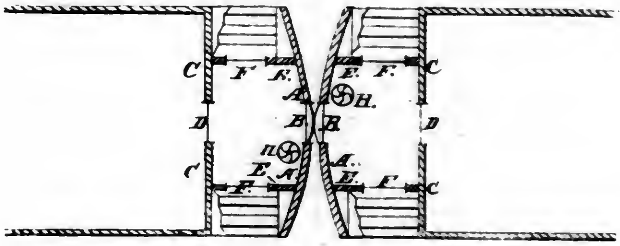


Fig. 7.
WATERBURY'S COUPLER. 1852.

The foregoing gives a clear idea of the state of the art at the time of Miller's 1863 patent.

It will be seen that, before Miller's 1863 patent, no one example existed of a hooked headed coupling, with the two bevels a a' and which was disconnected from a coupling or bumper-box. But, however, numerous examples existed of single beveled hooks connected with a coupling or bumper-box.

Now turn to the Janney coupler.

The hooks are formed by the pivoted tongues which, when fastened in one position, constitute a hook, and which, when left free, open so that no hook is formed. There is no sidewise motion of the coupler-shank as a whole as in Miller's, but only of the tongue. When the couplers of two cars are locked together the couplers act as buffers, and in fact do more in this regard than do the two side buffers. Springs are specially arranged on the shanks of the Janney couplers to act as buffers, and this function they must effectually perform. Now, it follows from this that the Janney coupling is not a hooked-headed coupling disconnected from a coupling or bumper-box, but is in fact a hooked-head coupling connected with a buffing-box, and in this regard it differs from the terms of Miller's fourth claim and is like the earlier examples shown by the state of the art.

Next, Janney's coupling has no double bevel. It can scarcely be said to have a single bevel. It certainly has not got the bevels a and a' of the Miller patent, and neither has it the operation which requires the use of these bevels. This is the view that the Court took, saying as follows:

The construction asked for by the plaintiff would necessarily eliminate from the claim in question one of the bevels referred to As I have said, the Court has felt that it could not without doing violence to the law in that respect construe the claim as omitting one of the bevels when the patentee has included both.

It being conceded by the experts on both sides, as you will doubtless recollect, that there is no equivalent in the Janney hook or coupler for the outside bevel, there can be no pretense that the claim is infringed.

Thus the Court passed on the question of infringement of the claim under consideration. Another reason existed for the withdrawal by the Court of the fourth claim of this 1863 patent from the jury, and this reason was that Miller himself had said, in the letter before quoted, that the Janney device did not infringe his 1863 patent, and this opinion once given could not be reversed or changed.

For these two reasons the 1863 patent of Miller was by the Court taken from the jury, which act on the part of the Court was equivalent to a verdict for the defendant as far as the 1863 patent was concerned. The Court holding that the patent was not infringed and that the Miller heirs were by their father's act estopped from saying that the Janney devices came within the scope of the claim.

THE RULO BRIDGE.

THE accompanying illustrations show the three short shore spans and one river span of the new bridge over the Missouri at Rulo, Neb.; also the details of the long or river span.

This bridge, now nearly completed, has been built for the Chicago, Burlington & Quincy Railroad Company under the supervision of Mr. George S. Morison as Chief Engineer. The foundations were put in by the company, and the masonry was put up by Drake & Stratton. The superstructure is the work of the Edge Moor Iron Company, of Wilmington, Del.

A full description of the bridge will be found in the specifications, the material part of which is given below:

GENERAL DESCRIPTION.

The superstructure will consist of three main through spans and six deck spans, three of which will be at each end of the structure.

Each through span will be 375 ft. long between centers of end pins, divided into 15 panels of 25 ft. each. The trusses will be 50 ft. deep and placed 22 ft. apart between centers. The top chord, end posts, bolsters, rollers, bearing plates, pins and all eye-bars, except counters and vertical suspenders, will be of steel; all other parts will be of wrought-iron, except the wall-plate pedestals and ornamental work which will be cast-iron. Each span will contain approximately 486,000 lbs. of steel, 484,000 lbs. of wrought-iron and 21,000 lbs. of cast-iron.

Each deck span will be 125 ft. long between centers of end pins, divided into 5 panels of 25 ft. each. The trusses will be 17 ft. 6 in. deep and placed 12 ft. apart between centers. The intermediate ends of each set of three spans will rest on iron towers measuring 25 ft. long in the direction of the bridge, making a total length of iron work in each group of three deck spans of 425 ft. The pins, rollers, bearing plates and eye-bars, excepting counters, will be of steel; all other parts will be of wrought-iron, except the wall-plate pedestals which will be of cast-iron. Each span will contain approximately 102,000 lbs. of wrought-iron and 31,000 lbs. of steel. Each group of three spans, including the towers, will contain approximately 93,000 lbs. of steel, 398,000 lbs. of wrought-iron and 16,000 lbs. of cast-iron.

The total estimated weight of the entire structure is approximately 4,000,000 lbs.

PLANS.

Full detail plans, showing all dimensions, will be furnished by the Engineer. The work shall be built in all respects according to these plans. The contractor, however, will be expected to verify the correctness of the plans, and will be required to make any changes in the work which are necessitated by errors in these plans, without extra charge, where such errors could be discovered by an inspection of the plans.

MATERIALS.

All materials shall be subject to inspection at all times during their manufacture, and the Engineer and his inspectors shall be allowed free access to any of the works in which any portion of the material is made. Timely notice shall be given the Engineer so that his inspectors may be on hand.

Steel.—The steel used will be of two classes, viz.: High Steel, which will be used in compression members, bolsters, bearing plates, pins and rollers; and Low Steel, which will be used for tension members and rivets.

Steel may be made by the open-hearth or by the Bessemer process, but no steel shall be made at works which have not been in successful operation for at least one year; steel made by the Clapp-Griffiths process will not be accepted. All melts shall be made from uniform stock, low in phosphorus, and the manufacturer shall furnish satisfactory evidence to the Engineer that this class of material is being employed, it being understood that the furnished product is to be one in which the phosphorus does not average more than 0.08 per cent. and never exceeds 0.10 per cent.

A sample bar ¾ in. in diameter shall be rolled from every melt; the method of obtaining the piece from which this sample bar is rolled shall be the same for all samples, and the amount of work on this sample bar shall be as nearly as practicable the same as on the finished product. The laboratory tests shall be made on this sample bar in its natural state without annealing.

The laboratory tests of High Steel made on the sample bar shall show an elastic limit of not less than 50,000 lbs. per square inch, an ultimate strength of not less than 80,000 lbs. nor more than 90,000 lbs., an elongation of at least 15 per cent. in 8 in. and a reduced area of at least 35 per cent. at the point of fracture. In a bending test, the sample bar shall bend 180° around its own diameter without showing crack or flaw.

The laboratory tests of Low Steel made on the sample bar shall show an elastic limit of not less than 40,000 lbs. per square inch, an ultimate strength of not less than 70,000 lbs. nor more than 80,000 lbs., an elongation of at least 18 per cent. in a length of 8 in., and a reduction of at least 42 per cent. at the point of fracture. In a bending test, the sample bar shall bend 180° and close back against itself without showing crack or flaw on the outside of the curve.

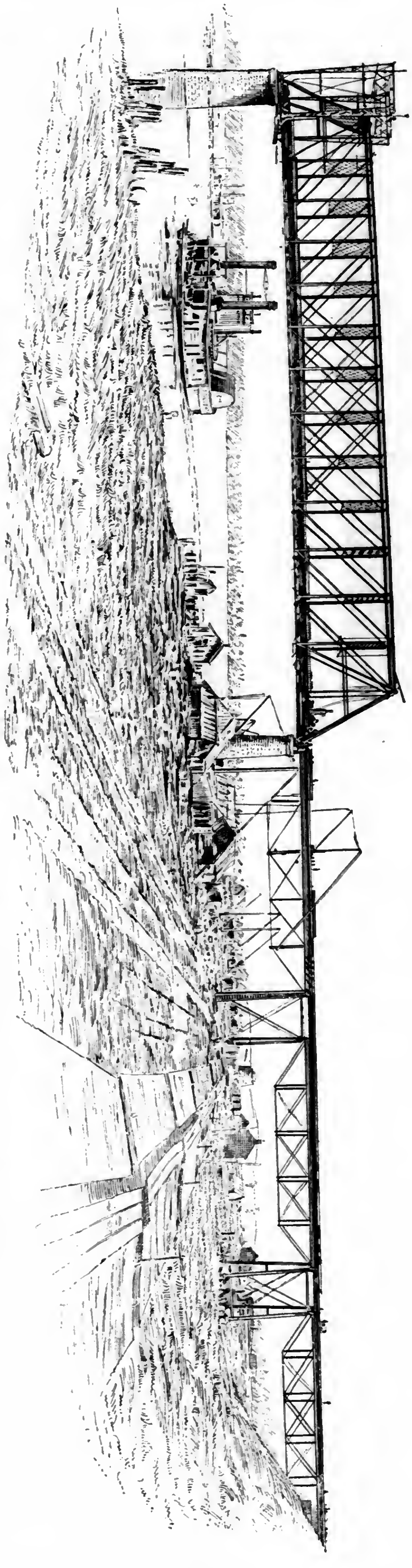
The softest melts shall be selected for rivets, and the only requirements as to elastic limit and ultimate strength will be that the ultimate strength shall be at least 60,000 lbs. per square inch.

Facilities for testing sample bars shall be furnished by the contractor at a point convenient to the steel works, and the tests shall be made at the expense of the contractor and under the direction of the Engineer. Tests may also be made from time to time on samples cut from finished plates, shapes and bars, which shall show results substantially conforming to those shown by the sample tests of the same melts.

All sheared edges or punched holes in steel work shall be subsequently planed or drilled out, so that none of the rough surface is ever left upon the work. Steel for pins shall be sound and entirely free from piping.

Wrought Iron.—The iron used in tension members shall be double-refined (high test) iron; muck bars may be used at the center of the pile, but shall not constitute more than one-third of the total pile. Small samples, having a minimum length of 8 in., shall be furnished by the contractor for testing, as directed by the Engineer; these samples shall show an elastic limit of at least 26,000 lbs. and an ultimate strength of at least 50,000 lbs. per square inch, shall elongate at least 15 per cent. and shall show a reduced area of at least 25 per cent. at the point of fracture. The fracture shall be of uniform fibrous character, free from crystalline appearances.

Small samples, having a minimum length of 8 in., shall



BRIDGE OVER THE MISSOURI RIVER AT RULO, NEBRASKA; CHICAGO, BURLINGTON & QUINCY RAILROAD.

GEORGE S. MORISON, CHIEF ENGINEER.

THE EDGE MOOR IRON COMPANY, }
DRAKE & STRATTON, } CONTRACTORS.

be furnished by the contractor from the iron used in shapes, plates and other miscellaneous forms, as directed by the Engineer; these samples will show an elastic limit of at least 24,000 lbs. and an ultimate strength of at least 47,000 lbs. per square inch, shall elongate at least 10 per cent. before breaking, and show a reduction of area of at least 15 per cent. at the point of fracture. In plates more than 30 in. wide an elongation of 8 per cent. and a reduction of 12 per cent. at the point of fracture will be considered satisfactory.

Cast-iron shall be of the best quality of tough, gray iron.

RIVETED WORK.

All plates, angles and channels shall be carefully straightened before they are laid out; the rivet-holes shall be carefully spaced in truly straight lines; the rivet-heads shall be of hemispherical pattern, and the work shall be finished in a neat and workmanlike manner. Surfaces in contact shall be painted before they are put together. The dimensions given for rivets on the plans are the diameters of the rivets before driving.

Power riveters shall be direct-acting machines, capable of exerting a yielding pressure and holding on to the rivet when the upsetting is completed.

Steel.—The several parts of each steel member shall be assembled, and the holes shall be drilled, the sharp edge of the drilled hole shall be trimmed so as to make a slight fillet under the rivet head, and the pieces shall be riveted together without taking apart. Should the contractors desire, the parts may be punched with holes not exceeding four-fifths the diameter of the finished hole, and this punching shall be so accurate that at least $\frac{1}{16}$ in. of metal is taken out all around in drilling the hole. All rivets in steel members shall be of steel; the rivet-holes shall be of such size that they will fill the hole before driving, and whenever possible the rivets shall be driven by power. All bearing surfaces shall be truly faced. The chord pieces shall be fitted together in the shop in lengths of at least five panels and marked; when so fitted there shall be no perceptible wind in the length laid out. The pin holes shall be bored truly so as to be at exact distance, parallel with one another, and at right angles to the axis of the member.

Wrought Iron.—All wrought-iron work shall be punched accurately with holes $\frac{1}{16}$ in. larger than the size of the rivet, and when put together a cold rivet shall pass through every hole without reaming. So far as possible all rivets shall be driven by power. The holes for the rivets connecting the floor-beams with the posts and bolsters and the stringers with the floor-beams, and, in general, the holes for all rivets which must be driven after erection, shall be accurately drilled to an iron templet. The holes for the rivets connecting the floor-beams with the posts shall be 1 in. in diameter, and the rivets of corresponding diameter. The pin-holes in the vertical posts shall be truly parallel with one another and at right angles to the axis of the posts. The posts shall be straight and free from wind.

FORGED WORK.

The heads of steel eye-bars shall be formed by upsetting and forging into shape by such process as may be accepted by the Engineer. No welds will be allowed. After the working is completed, the bars shall be annealed by heating them to a uniform dark red heat throughout their entire length and allowing them to cool slowly. The form of the heads of steel eye-bars may be modified to suit the process in use at the contractor's works, but the form of head adopted must be such as to meet the requirements of the tests of full-sized bars.

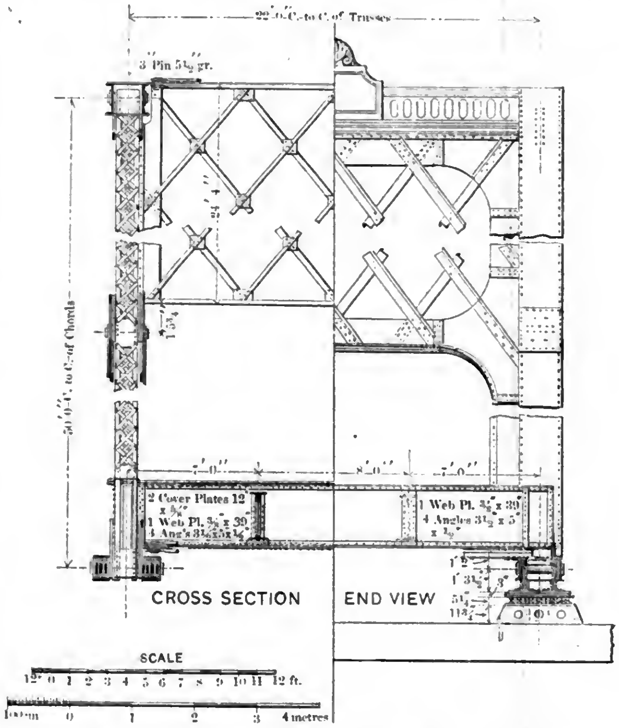
The heads and the enlarged ends for screws in laterals, suspenders and counters shall be formed by upsetting or by an upsetting and welding process acceptable to the Engineer. Welds in the body of the bar will not be allowed.

TESTS OF FULL-SIZED STEEL BARS.

Ten full-sized eye-bars of sections and lengths used in the actual work shall be selected by the inspector for testing; each of these full-sized bars shall be strained till an elongation of 10 per cent. is obtained, and, if possible, broken; if broken, the fracture shall occur in the body of the bar and shall show a uniform ductile quality of material.

The contractor will be required to furnish facilities for testing the full-sized bars within a reasonable distance of his works. Should the contractor be unable to furnish such facilities, he shall be required to furnish bars at 20 per cent. larger section than those called for, without change for the increased weight.

The full-sized bars shall be selected from time to time as the work proceeds, the last bar not to be selected till all the eye-bars are manufactured. The tests shall be made from time to time as the bars are selected. When three bars have been tested, the bars manufactured up to the time of the selection of these three test bars shall be accepted or rejected as the results of such tests, and the same shall be done again when three more bars are tested. In the tests, the failure of one bar to develop a stretch of 10 per cent. before breaking shall be sufficient reason for rejecting the whole lot; but a failure to break in the body of the bar shall not be a sufficient ground for condemnation



THE RULO BRIDGE, DETAILS OF 375 FT. SPAN.

if it does not occur in more than one-third of the bars tested. Should the contractor on the first attempt fail to make bars coming up to the required specifications, the Engineer may order bars of 20 per cent. larger section than the plans call for, to be furnished by the contractor without charge for the increased weight.

MACHINE WORK.

The bearing surfaces in the top chord shall be truly faced. The ends of the stringers and of the floor-beams shall be squared in a rotary facer. All surfaces so designated on the plans shall be planed.

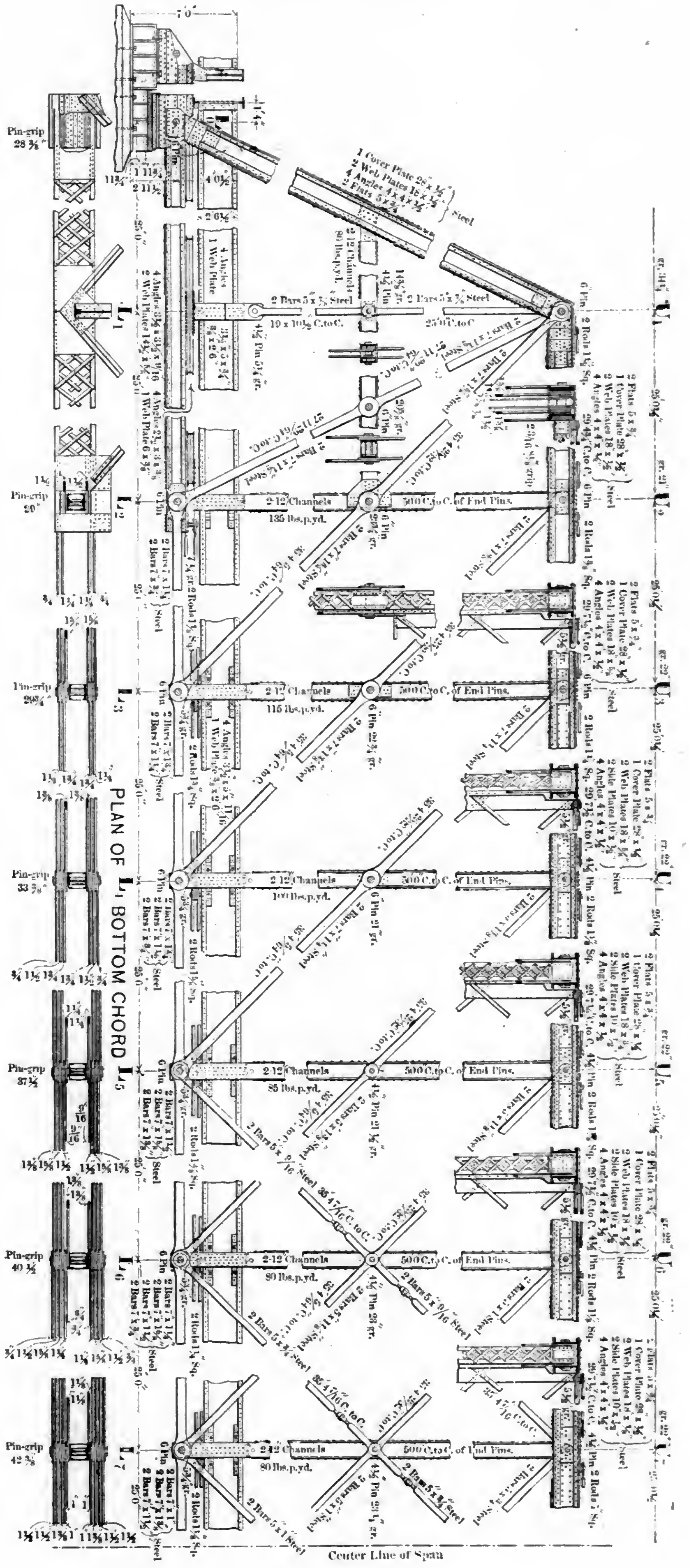
All pins shall be accurately turned to a gauge, and shall be of full size throughout; pin-holes shall be bored to fit the pins, with a play not exceeding 0.02 in. These clauses apply to all lateral connections as well as to those of the main trusses. Pins shall be supplied with pilot nuts for use during erection, four for each size of pin.

All screws shall have a truncated V-thread, United States standard.

MISCELLANEOUS.

All workmanship and material, whether particularly specified or not, must be of the best kind now in use in

DETAILS OF 375 FT. SPAN.



BRIDGE OVER THE MISSOURI RIVER AT RULO, NEBRASKA; CHICAGO, BURLINGTON & QUINCY RAILROAD

GEORGE S. MORISON, CHIEF ENGINEER.

THE EDGE MOOR IRON COMPANY, DRAKE & STRATTON, } CONTRACTORS.

first-class bridge-work. Flaws, ragged edges, surface imperfections or irregular shapes will be sufficient ground for rejection; rough and irregularly finished work will not be accepted.

Machine-finished surfaces shall be coated with white lead and tallow before shipment; all other parts shall be given a coat of hot boiled linseed oil.

The Foundation of the Central Viaduct at Cleveland.

[Report read by W. H. Searles, Chairman of Committee on Civil Engineering of the Civil Engineers' Club of Cleveland; published in the *Journal of the Association of Engineering Societies.*]

THE Central Viaduct now under construction in the city of Cleveland, Ohio, is probably the longest structure of the kind devoted entirely to street traffic. The superstructure is in two distinct portions, separated by a point of high ground. The main portion extending across the river valley from Hill Street to Jennings Avenue is 2,840 ft. long on the floor line, including the river bridge, a swing 233 ft. in length; the other portion, crossing Walworth Run from Davidson Street to Abbey Street, is 1,093 ft. long. Add to these the earthwork and masonry approaches, 1,415 ft. long, and we have a total length of 5,348 ft. The width of roadway is 40 ft.; sidewalks, 8 ft. each. The elevation of the roadway above the water level at the river crossing is 102 ft. The superstructure is of wrought-iron, mainly trapezodial trusses varying in length from 45 ft. to 150 ft. The river piers are of first-class masonry on pile and timber foundations. The other supports of the viaduct are wrought-iron trestles on masonry piers, resting on broad concrete foundations. The pressure on the material beneath the concrete, which is plastic blue clay of varying degrees of stiffness mixed with fine sand, is about one ton per square foot.

The Cuyahoga Valley, which the viaduct crosses from bluff to bluff, is composed mainly of blue clay to a depth of over 150 ft. below the river level. No attempt is made to carry the foundation to the rock. White-oak piles of from 50 to 60 ft. in length and 10 in. in diameter at small end are driven for the bridge piers either side of the river bed, and these are cut off with a circular saw 18 ft. below the surface of the water. Excavation by dredging was made to a depth of 3 ft. below where the piles are cut off to allow for the rising of the clay during the driving of the piles. The piles are spaced about 2 ft. 5 in. each way, center to center. The grillage or platform covering the piles consists of 14 courses of white-oak timber 12 in. by 12 in. having a few pine timbers interspersed so as to allow the mass to float during construction. The lower half of the platform was built on shore, care being taken to keep the lower surface of the mass of timber out of wind. The upper and lower surfaces of each timber were dressed in a Daniels planer, and all pieces in the same course were brought to a uniform thickness. The timbers in adjacent courses are at right angles to each other. The lower course is about 58 ft. by 22 ft., the top course about 50 by 24 ft., thus allowing four steps of 1 ft. each all around. The first course of masonry is 48 ft. by 21 ft. 8 in.; the first course of battered work is 41 ft. 8½ in. by 16 ft. 3 in. Thus the area of the platform on the piles is 1,856 square ft. and of the first battered course of masonry 777.6 square ft., or in the ratio of 2.4 to 1. The height of the masonry is 78 ft. above the timber, or 73½ ft. above the water. The number of piles in each foundation is 312. The average load per pile is about 11 tons, and the estimated pressure per square inch of the timber on the heads of the piles is about 200 pounds.

To prevent the submersion of the lower courses of masonry during construction, temporary sides of timber were drift-bolted to the margin of the upper course of the timber platform, and carried high enough to be above the surface of the water when the platform was sunk to the head of the piles by the increasing weight of masonry.

The center pier is octagonal, and is built in the same general manner as to foundations as the shore piers, but the piles are cut off 22 ft. below water, and there are 18 courses of timber in the grillage. The diameter of the platform between parallel sides is 53 ft., while that of the lower course of battered masonry is but 37 ft. The areas are as 2,332 to 1,147, or as 2 to 1, nearly. The pressure per square inch of timber on the heads of the piles is about the same as stated above for the shore piers. The number of piles under the center pier is 483.

The risks and delays by this method of constructing the foundations were much less, and the cost also, than if an ordinary coffer dam had been used. Also the total weight of the piers is much less, as that portion below a point about 2 ft. below the water adds nothing to their weight.

The piles were driven with a Cram steam hammer weighing two tons, in a frame weighing also two tons. The iron frame rests directly upon the head of the pile and goes down with it. The fall of the hammer is about 40 in. before striking the pile. The total penetration of the piles into the clay averaged 27 ft. The settlement of the pile during the final strokes of the hammer varied from ¼ to ¾ in. per blow.

There are 122 masonry pedestals, of which 8 are large and heavy, carrying spans of considerable length. They will all be built upon concrete beds except a few near the river on the north side, where piles are required.

The four abutments with their retaining walls are of first-class rock-faced masonry. The footing courses are stepped out liberally, so as to present an unusually large bottom surface. They rest on beds of concrete 4 ft. thick. The foundation pits are about 50 ft. below the top of the bluffs and are in a material common to the Cleveland plateau, a mixture of blue sand and clay with some water. The estimated load of masonry on the earth at the bottom of the concrete is 1.7 tons to the square foot. Two of the large abutments were completed last season. They show an average settlement of ⅜ in. since the lower footing courses were laid.

The facts and figures here given regarding the viaduct were kindly furnished by the City Civil Engineer, C. G. Force, who has the work in charge.

The Preservation of Railroad Ties and Timber by the Use of Antiseptics.

[Paper read by Joseph P. Card before the Western Society of Engineers; from the *Journal* of the Association of Engineering Societies.]

THE antiseptics that have been used up to the present time, to any considerable extent, in the preservation of railway ties and timber are: Corrosive sublimate, kyanizing; sulphate of copper, Boucherie; chloride of zinc, Burnettizing; and dead-oil, creosoting.

Many others, however, have been tried in the past 50 or more years, and abandoned for one cause and another, which I will not attempt to explain, but will confine my remarks to those now in use.

Corrosive sublimate is the most powerful poison of them all, and its antiseptic properties are some 50 or more times greater than sulphate of copper or chloride of zinc; that is, a solution of one part corrosive sublimate in 10,000 parts of water would, according to the best authorities, be more than an equivalent to sulphate of copper, diluted one part in 400, or chloride of zinc, one part in 200 of water, which is about the minimum at which they will preserve.

In treating timber with corrosive sublimate, it is generally placed in large wooden vats for one day for each inch in thickness, not counting the day it is put in or taken out, or say 10 days for an 8 in. × 8 in. square stick.

The handling of the timber after treatment has to be done with care, or serious consequences may follow. The solution used has generally been one part in 100 of water.

The treatment with sulphate of copper has generally been done by the Boucherie process, or in copper cylinders, on account of its corrosive properties, while the treatment with chloride of zinc is done in iron cylinders, which cost, say, 10 times less than copper. All three of these salts being more or less liable to be chemically changed or washed out of the wood, and as the chloride

of zinc has, under most conditions, when injected in proper quantities, answered equally as well, and being cheaper and more economically handled, it has come more generally into use than either of the others. In fact, comparatively speaking, corrosive sublimate and sulphate of copper have practically gone out of use.

Chloride of zinc has served a good purpose in the preservation of railroad ties in Germany, while in England the treatment has not been satisfactory—in fact, has been abandoned. Now, why this great difference in results? The road-beds are, as I understand it, alike (rock-ballasted); consequently, the drainage is the same. It must be on account of the impurities absorbed into the ties, from England's moist climate, which changes gradually the chloride into a non-antiseptic, for rainfall, as a rule, will not, so far as my observations go, wash it out. It takes more than rain; in fact, it means submerging it in water, and this would hardly occur on a rock-ballasted roadbed. If a tie were reasonably dry and in rock ballast, and it should rain, it would absorb moisture slowly as it rained; the flow would be inward, taking more or less of the salt with it, for any of the soluble salts mentioned will, to a certain extent, move around through the wood in whatever direction the moisture goes. When it rains, it goes inward or towards the center; when the moisture evaporates, to the point of evaporation. I have had this tested by analysis, to my entire satisfaction.

If ties were submerged, or partially so, in water for any considerable time, the chloride being of greater specific gravity than water, its tendency would be to go out of the ties rather than inward, or to equalize with the water surrounding them. Again, if the ties were in sand (like the Rock Island ties, which I will mention later on), the result would be, when your sand was moist or wet they would absorb moisture where they came in contact with it, and as it gradually moved to the point of evaporation, which would be the top or exposed portion of the tie, it would carry with it more or less of the chloride. This constant or, at certain seasons of the year, long-continued, evaporation weakens, in my opinion, the strength of the chloride at point of contact with the ground or moisture below the minimum of its preserving properties, and in the case of the Rock Island ties, which were in clean sand, they gradually decayed where they came in contact with the ground, but remained sound on top, as a general thing.

Again, should there be impurities in the ground or water surrounding the ties, or in the rainfall, that would combine with the chloride or any salt and transform it into a non-antiseptic, as oxide of zinc, the change would be more or less rapid, and it is in this way that I account for the bad results with chloride of zinc in England; and from rainfall, if the ties are on rock ballast.

I know of Burnettized gumwood ties that were placed in cinder and slack-coal ballast in 1880 (the cinders and slack came from a coal-mine dump which had been burned over) which were worthless in 12 months after being placed in the track, while ties treated at the same time, that were placed in sand, are sound to-day, or were when I examined them last year.

I do not mean to say that all cinders and slack will produce this result, but these did; neither do I wish to convey the idea that the changes mentioned heretofore occur in a day. Some of them may in a month, or, as in the case of the Rock Island ties, their average life was over 15 years.

There is a section of some 20 miles of the Union Pacific Railroad where the ties have been preserved, ever since the road was first built, by the soil in which they lie.

With reference to creosoting or the use of dead-oil in wood-preserving, if you inject a sufficient quantity of oil (of proper quality, after steaming and vacuum) into ties or timber, they will remain sound so long as the oil remains undisturbed, if it enters the wood but ½ in., or even less, on the sides of, say, a 10 in. × 10 in. stick of timber, notwithstanding the oil remains practically where it is placed at time of treatment, and does not diffuse through the wood, like chloride of zinc, and for the following reasons:

Dead-oil contains carbolic and other acids, which are more or less soluble in water, and enough of these acids combine with the moisture in the wood at time of treatment to destroy the fermentable or other matter then in the wood, that tends to decay, and any impurities or germs of decay thereafter coming from the outside will have to pass through the dead-oil, and in doing so are destroyed or rendered inert.

The trouble with creosoting is to get the dead-oil where you want it (it will stay where you put it) and the cost. The trouble with a mineral salt or chloride of zinc is to keep it where you put it, or where it places itself shortly after treatment, if the work on your part is properly done.

Having given you my experience, as well as ideas as to the benefits to be expected from the proper use of mineral salts and dead-oil when used by themselves, I will now submit for your consideration and discussion before this Society the process known as the "zinc-creosote" process, which consists in the use of both dead-oil and chloride of zinc in combination, for the preservation of railroad ties and timber from decay, as well as protection against the attacks of the teredo where timber is placed in the sea.

For railroad ties, bridge-timber and the like, or where timber is subjected to no considerable moisture, as when placed on or in the ground, the process is as follows:

After preparing the timber in the usual way, by steaming and vacuum, the dead-oil is run into the cylinder, and such quantity as may be desired is forced into the wood.

For railroad ties or timber, I would recommend, say, ½ gallon to the cubic foot, or 1½ gallons to the tie. A less amount may be found to answer. After the timber has been treated with oil, the oil is removed and the cylinder charged with chloride of zinc, when, by pressure, it can be made to enter the wood, pass through and beyond the oil, and impregnate by diffusion that portion of the wood that the oil will not penetrate, especially where timber is not well-seasoned or dense like oak. The aim of this process is to get the benefit of the dead-oil treatment where ties or timber come in contact with the ground or moisture, with one-half or less oil, besides having those portions of the wood not penetrated by the oil impregnated by the zinc chloride. The zinc chloride, surrounded as it is by oil, should be protected for a long time in railroad ties or bridge timber against moisture. I find that less than one-half the quantity of oil used in ordinary creosoting can be distributed by this process through every portion of the wood penetrated by the greater quantity injected in the usual way.

Creosoting, as practiced abroad, unless a much larger quantity of oil is used on railroad ties than is used in England (6 to 10 pounds to the cubic foot), is of little value, in my opinion, unless a chair is placed under the rail, to take the wear, for the following reasons:

Where dense woods are used—and, in fact, it is the case also with many of those woods which are considered porous—the heart-wood will take the oil but skin-deep; consequently, the oil is in time worn off by the rail, decay begins, and at the worst possible place, the spike becomes loose and the tie valueless.

This is probably the reason why there were so few American creosoted ties shown at the Exhibition of Railroad Appliances in 1883, and the few that were there had been treated to at least 2 gallons of oil to the cubic foot. If I am not correct, I would ask what has become of the thousands that have been treated in the past 30 years in this country, where we use no chairs under the rails?

I have here one of a lot of ties treated by a Mr. Pelton some years since for the Chicago, Rock Island & Pacific Company, and put in the track near Englewood, Ill. It was taken up in May, 1883, to be shown at the Chicago Exposition of that year. These ties were treated in 1872 by what is known as the Seely process, and although they contained but little oil (less than 4 lbs. to the cubic foot), they were sound, so far as examined by me, where they came in contact with the ground, but commenced to decay (so I was told) under the rail as soon as the oil wore off, and not before.

If a sufficient quantity of oil is used to impregnate the ties to a considerable depth at point of contact with the rail (which means for oil 50 cents, or 6 gallons to the tie, and this applies to soft woods only, and not to oak), a good result would be obtained; otherwise, a chair must be used.

If you will show me one tie that has served a good purpose, I will convince you that it was treated to, at least, 6 gallons of oil, or a chair had been used. Not but what a much less quantity would preserve it from decay, if it were placed in the ground as a post, and undisturbed; but should you remove the oil at the ground line—it matters not to what extent, so that the untreated timber is exposed, you will find your creosoting of little value, and this is the experience of all.

Mr. J. W. Putnam, of New Orleans, in a letter to the Chairman of the Committee on Preservation of Timber of the American Society of Civil Engineers, says: "With reference to creosoting, wherever the coating is broken, and the air, with its dust, allowed to come in contact with the untreated wood, decay follows, and extends in each direction from the opening," and he is but one of the many who make this or similar statements.

The Burnettized ties on the Chicago, Rock Island & Pacific Railway, near Englewood—and, so far as I have examined, those on other roads also, where the work was well done—were sound under the rail, but decayed where they came in contact with the ground. Mr. Alexander, in his report of March 23, 1882, to Mr. Hugh Riddle, then President of the Rock Island Company, says: "I have made a careful examination of the Burnettized hemlock ties we laid in the main track just west of Englewood in November, 1866, last summer, and found at least 75 per cent. of them still in the track, and, in my opinion, in such a state of preservation that they will be serviceable for two or three years longer. Some 5 or 6 of these ties were taken out of track, and found to be sound and solid in the center, and only decayed to the depth of ½ to ¾ in. on the surface and sides. The rail has not worn into these hemlock ties to any greater extent than would have occurred with oak, and they hold a spike fully as well as the oak tie. The pine and cedar ties that were Burnettized at the same time have worn out in the 15 years' service, and have disappeared. The tamarack have held out about the same as the hemlock." Continuing, he says: "My experience is that untreated hemlock ties decay first in the center or heart, when the spike becomes loose and the tie crumbles; but these treated ties are sound in the center, which shows that where the chloride of zinc is not washed out, the wood is in a perfect state of preservation."

I saw these ties a short time after they were taken up, and examined those remaining in the track in June, 1883 (they had then been down over 17 years), and found them to be sound under the rail, with hardly an exception. I also had the sound wood from several of these ties analyzed, and found them to contain from 0.05 to 0.14 per cent. of chloride of zinc to weight of the wood when dry.

Again, in the same report (March 23, 1882), Mr. Alexander says: "In 1872, we laid in second track, east of Washington Heights, about 5,000 hemlock ties that were subjected to the creosoting process. These ties I do not believe to have been thoroughly treated. They seemed to be tolerably sound at the bottom, but are badly decayed on the surface, and the rail wears into them to a much greater extent than it does into those that were treated with chloride of zinc. There is probably not more than from 30 to 50 per cent. of these creosoted ties now in track, and these will, no doubt, all be taken out this summer.

I examined these ties, or what there was left of them, in June, 1883, finding few then in the track, but was fortunate, however, in finding several hundred that had just been taken up and piled along the track.

If I am correct, what can be expected of creosoted ties with but 6 to 10 lbs. of oil to the cubic foot, if used, as they are in this country, in direct contact with the rail, and what must we do to get best results in the preservation of our ties? Use a chair, as in England, or open, porous woods, and inject 50 to 75 cents' worth of oil into each tie; or will a double treatment, first with dead-oil and then with chloride of zinc, answer the purpose—the dead-oil to preserve the outer or exposed parts, which it will do, and the zinc chloride the central portions, which the oil does not penetrate to any considerable extent in our most desirable woods? So far as my observations and experiments go, I am satisfied that time will demonstrate that dead-oil and chloride of zinc, injected into ties and timber as proposed, will give the best results for money invested, and where dense woods are used, especially for ties, the best result, without regard to cost.

You may say that the old way of creosoting closed the pores, thereby keeping out moisture. Dead-oil will not keep moisture in or out of wood, like paint, tar or pitch, for any considerable time. Moisture will not enter a creosoted tie above the surface of the water surrounding it, or without pressure; neither will it enter, except under same conditions, where the fiber is oiled. This being the case, your ties, under most conditions, will remain dry, and the zinc chloride should be protected.

Again, you seldom see decay in wood, the fiber of which has once been covered with dead-oil to such an extent as to be seen by the eye. The zinc-creosote process will, as I said before, distribute one-half or less oil in every part penetrated by the greater quantity when injected in the old way, and in such quantities as can be readily seen.

You may say: Would it not be better to first inject the chloride, and then the dead-oil? If the treatment were reversed, you would have to remove a portion of the moisture before the oil could be injected. Wood being one of our best non-conductors of heat, the process would be tedious, and timber or ties would be more or less injured by the long-continued application of the heat required to evaporate sufficient moisture. In fact, the only cheap and practical way would be to air, dry or stack the timber until sufficient moisture has evaporated, and then apply the oil. I do not believe there would be anything gained by so doing, and it would add greatly to the cost.

With reference to the treatment of piling with dead-oil, as protection against the teredo, the old way is to inject all the oil the timber will take (which depends on the piles being more or less dry and the kind of wood operated on), from one to three gallons to the cubic foot. The object of the zinc-creosote process is to economize in the quantity of oil used and nothing more, and consists in first injecting, say, two-thirds (one-half may be found to answer) of the quantity used in the old way, and then, by substituting some other fluid for the oil, as chloride of zinc, air or water, by pressure, compress or force the two-thirds previously injected solidly to the center, which leaves the two ends—the one in the mud or ground, the other above water—with their fibers virtually painted with the dead-oil, while the center of the pile or that portion in the water is as well treated and contains as much oil as would be the case if the whole quantity used had been oil. I would prefer an antiseptic for the second injection, as it would help to preserve that portion above water from decay.

Iron and Steel Production in 1856 and 1886.

(From the *Bulletin* of the American Iron & Steel Association.)

THE following tables were contributed by James M. Swank to the special report on the Mineral Resources of the United States, to be made in 1887 by David T. Day, Chief of the Division of Mining Statistics and Technology of the United States Geological Survey:

PRODUCTION OF IRON AND STEEL IN 1886 COMPARED WITH 1856.

The following table, compiled from the records of the American Iron & Steel Association, gives for comparison the production of some of the leading articles of

iron and steel in 1856 and 1886 in all the grand divisions of the United States. While not comprehensive of the whole range of our iron and steel industries it is complete for the products mentioned. This table shows very clearly the relative growth of the different grand divisions in the manufacture of iron and steel in the last 30 years, which takes us back to four years before the civil war:

Territorial Divisions.		Net tons of 2,000 lbs., except nails.				
		Pig iron.	Rolled iron including iron nail plate and iron rails.	Nails. Kegs of 100 lbs.	Rails of iron and steel.	Blooms from pig, scrap and iron ore.
New England	1856	34,051	78,989	560,000	20,015	6,776
	1886	32,574	99,952	516,749	19,683	175
Middle States	1856	614,593	366,542	1,021,709	124,708	63,790
	1886	3,684,793	1,373,312	2,948,420	1,175,878	36,985
Southern States	1856	143,184	70,601	217,168	12,869	19,619
	1886	875,179	156,801	1,550,941	4,990	4,734
Western States	1856	119,370	41,718	25,872	2,070	1,517
	1886	1,757,739	606,438	2,868,317	580,155	15
Far West'n States	1856	....	....	....	....	....
	1886	15,043	47,119	276,546	11,895	....
Total	1856	911,698	557,850	1,824,749	159,662	91,702*
	1886	6,365,328	2,283,622	8,160,973	1,792,601	41,909

* Including 7,000 gross tons sold direct in bars from the bloomaries and about 14,000 gross tons hammered into bars, axles and anchors by the forges, leaving 68,182 net tons as the total quantity of blooms going into rolling mills.

All the rails made in 1856, namely, 159,662 net tons, were iron rails, while all those made in 1886, namely, 1,792,601 net tons, were steel rails, except only 23,679 net tons of iron rails. During the period covered by these 30 years we built up an iron-rail industry which, in 1872, produced 905,930 net tons of iron rails, and when iron rails had served their day we built up a steel-rail industry which, in 1886, produced 1,768,922 net tons of steel rails. This change from iron to steel rails is one of the most remarkable events in our history.

It will be seen that the manufacture of iron and steel in the United States is a widely extended industry and one which is eminently national in its character. Every grand division of the country is represented in the foregoing table—the Middle States leading, followed in order by the Western States, the Southern States, New England and the Far Western States and Territories.

OUR PRODUCTION OF IRON AND STEEL COMPARED WITH THAT OF OTHER COUNTRIES.

While the foregoing statistics show the wonderful progress of our country in the manufacture of iron and steel in recent years, the commanding position which it has attained as an iron and steel manufacturing country is best shown by a comparison of its achievements with those of other countries.

The following table gives the world's production of pig iron and steel in the most recent years for which statistics are available. English tons of 2,240 lbs. are used in giving the statistics of Great Britain, the United States, Russia and other countries, and metric tons of 2,204 lbs. for all the Continental countries of Europe except Russia. As the difference between the gross ton and the metric ton is so trifling it is not necessary to change official figures:

Countries.	Pig iron.		Steel.	
	Years.	Tons.	Years.	Tons.
Great Britain	1886	6,870,665	1886	2,364,670
United States	1886	5,683,329	1886	2,562,502
Germany and Luxemburg	1886	3,489,231	1886	1,360,620
France	1886	1,507,850	1886	466,913
Belgium	1886	697,110	1886	139,215
Austria and Hungary	1886	726,835	1886	256,023
Russia	1882	498,400	1882	225,140
Sweden	1885	464,737	1885	80,550
Spain	1883	139,920	1886	15,000
Italy	1884	18,405	1884	3,450
Other countries (estimated)	1886	150,000	1886	30,000
Total	....	20,246,482	....	7,504,083
Percentage of the U. S.	....	28	....	34

This table places the United States first in the production of steel, and second only to Great Britain in the production of pig iron. We may add that it is also the first country in the production of rolled iron. In 1886, Great Britain rolled 1,616,701 gross tons of puddled iron, a much larger quantity than any other European country, while in the same year the United States rolled 2,038,948 gross tons, or 422,247 tons more than Great Britain. We did not, however, pass our great rival in the production of steel until last year, this circumstance alone justifying the designation of 1886 as a remarkable year for the American iron trade. In that year we made 197,832 gross tons more steel than Great Britain.

The United States is shown by the table to be the producer of 28 per cent. of the world's annual output of pig iron, and of 34 per cent. of its anuual output of steel. This prominence must astonish the reader. But our prominence in the production of iron and steel gives less occasion for astonishment than our undoubted pre-eminence as consumers of iron and steel. We are the first country in the world in the consumption of pig iron, manufactured iron and steel. As has already been shown, we annually import from foreign countries, and particularly from Great Britain, large quantities of iron and steel in all forms, which we consume in addition to the products of our own iron and steel works. Our exports of iron and steel do not amount to 1 per cent. of our total production; hence, virtually all the iron and steel that we produce and import is consumed within our own borders.

THE WORLD'S PRODUCTION OF PIG IRON.

From the most reliable information that is obtainable we have compiled the following table of the world's production of pig iron at various periods since the close of the last century, with which we end our present summary of iron and steel statistics.

Years.	Gross tons.	Years.	Gross tons.	Years.	Gross tons.
1800	825,000	1870	11,900,000	1879	13,950,000
1830	1,825,000	1871	12,500,000	1880	17,950,000
1850	4,750,000	1872	13,925,000	1881	19,400,000
1856	7,000,000	1873	14,675,000	1882	20,750,000
1865	9,250,000	1874	13,500,000	1883	[illegible],000,000
1866	9,300,000	1875	13,675,000	1884	19,475,000
1867	9,850,000	1876	13,475,000	1885	19,100,000
1868	10,400,000	1877	13,675,000	1886	20,246,482
1869	11,575,000	1878	13,925,000		

No exhibit could more clearly and effectually show the progress which the civilized world has made in the nineteenth century in the use of iron and steel. We know that the nations of antiquity made but little iron and steel, and there is no reason to believe that prior to the close of the last century the nations of modern times made as much iron and steel annually by all processes of manufacture as they then made of pig iron. The world has, therefore, as our table shows, increased its production of iron in 86 years of the present century more than twenty-fold. Its increased production of steel in the same period has been relatively much greater.

RAILROAD SAFETY APPLIANCES.

(From the London *Engineering*.)

THE security afforded to railroad traveling by the block and interlocking systems is so great that it throws into high relief the occasional accidents which still occur. These are almost always traced to the human element of the system, and are shown to result either from carelessness or from mistakes. If the regulations of the companies were always carried out perfectly, and if men never gave way to indolence nor lost their accuracy of perception and presence of mind, these accidents would be confined to cases arising from the failure of some part of the train or of the permanent way. But there are so many "ifs" in the chain that it is certain to give way at times, the wonder being that it serves its purpose as well as it does.

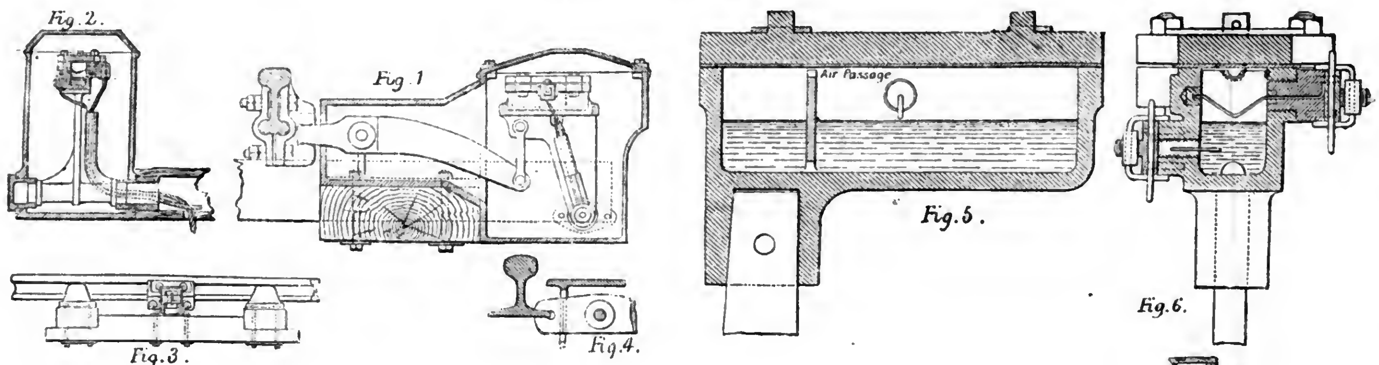
The mechanical and electrical arrangements in signaling operate so satisfactorily that many have tried to extend them, and to eliminate the men altogether. But no

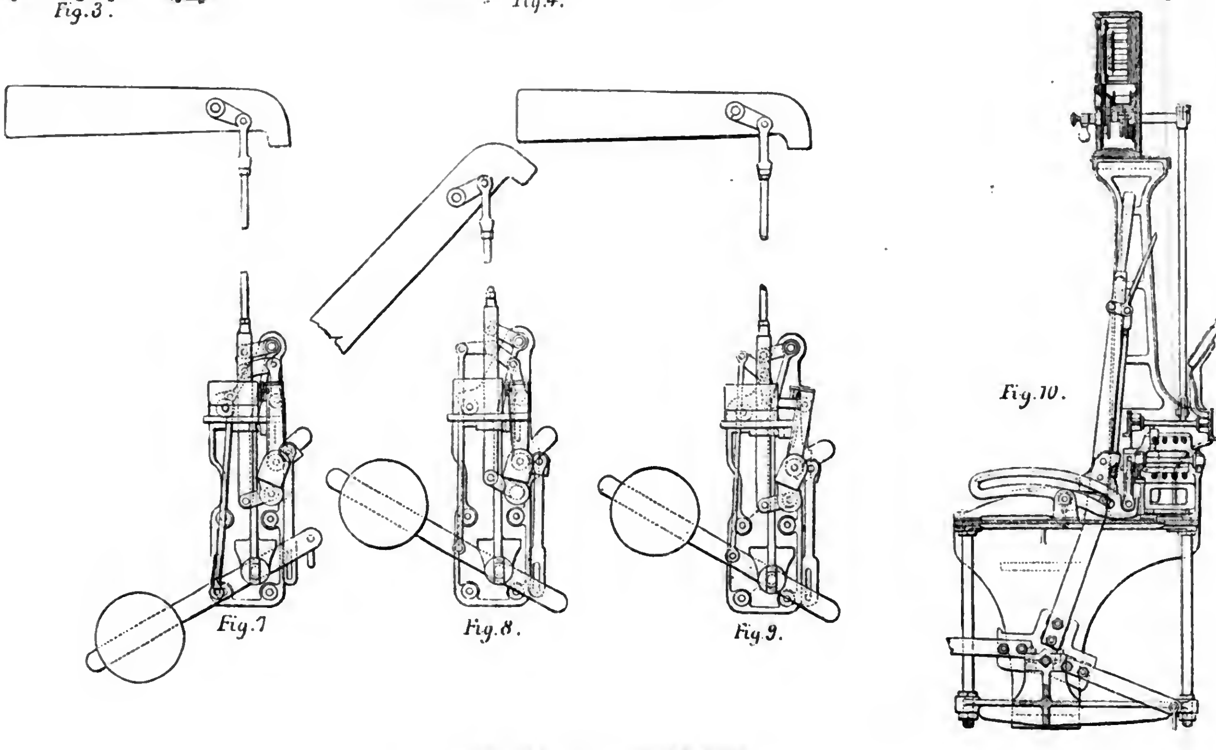
scheme of this kind has ever been propounded which a railroad engineer could be tempted to try, for although the present apparatus works well, yet no one would dare to trust it without constant supervision, and if the comparatively simple appliances which have been brought to their present state by years cannot be implicitly relied on, it follows that the more complex arrangement needed to enable trains to send their own indications would be sure to fail sooner or later. It may be confidently assumed, therefore, that the signalman is in no danger of being superseded by mechanical appliances for many years to come, and that any improvements which are introduced for the purpose of preventing him from lapsing into error will be designed rather to oblige him to fulfil his duties than to perform them for him. The block system is carried out on the hypothesis that the signalman has to perform a certain series of operations with military regularity, not exercising any option or judgment in the matter, and this feature needs to be kept in view in seeking to render it still more certain. At present a part of the series of acts which is needed for the passing of a train through a section, takes place in the mind of the man in charge; he receives a notification from an adjacent cabin requesting information, or ordering him to give a certain signal, and if he replies correctly or acts upon the instructions, all is well. But if not, a fearful accident may ensue, due not to any fault or weakness of the system, but to the agency by which it is carried out. If the apparatus were so constructed that on a man being asked a question from the adjoining cabin, he could give no answer except the correct one, and on receiving an order he could carry out no operation except that desired, then the human element would be so environed by checks and guards that it would be pulled up sharply if it diverged from the correct path, and all the harm it could do would be to delay the traffic by excess of caution.

An invention has lately been perfected by Messrs. Saxby & Farmer, of Kilburn, London, and is now on view at No. 31 Parliament Street, Westminster, designed to give increased security to our railway system in three ways. Firstly, it renders the working of the signals dependent upon the position and motion of the train, putting them up behind it when it enters a section (should the man neglect to do so) and making it impossible for them to be taken off until the train had gone out of the section. Secondly, it necessitates the conjoint action of the men at each end of a section to take off the signal at the entrance, this action having to be repeated for every train, while either man can put the signal to danger.

The two principal apparatus by which these ends are attained are an electrical treadle (figs. 1 to 6) and an electric slot (figs. 7 to 9). Fig. 10 shows the general arrangement of interlocking the block instruments with the point and signal levers when such interlocking is adopted, and fig. 11 is a diagram of an ordinary through station and shows the general arrangement of signals, block instruments, etc. Treadles of all kinds have been tried before; those acting mechanically soon get put out of order by the heavy and constant shocks to which they are subject, while the electrical ones suffer from the displacement of

RAIL CONTACT MAKER.





ELECTRIC SLOT APPARATUS.

SAXBY & FARMER'S IMPROVEMENTS IN RAILROAD SIGNALS.

the line, which either brings the contacts into constant connection, or removes them so far apart that they fail to meet when required. The problem of their construction does not appear particularly difficult at first sight, but the long list of failures which have taken place is evidence that the traffic imposes conditions which cannot be easily met. Messrs. Saxby & Farmer have avoided all the inconveniences resulting from changes of level by the use of a fluid medium—mercury—as one of the electric conductors. This is contained in a rectangular box, and over the center of its surface the contact point is placed. Now, if the box be inclined to one end or the other, the center of the fluid surface always keeps at the same height, and stands at the same distance from the terminal. If the box be shaken, however, the fluid surface breaks into waves, and the crest of one of these breaking against the contact wire (fig. 6) completes the circuit and sends a current to the cabin. In the longitudinal section of the box (fig. 5) there is shown a diaphragm with a space above and below it for the circulation of air and mercury. This diaphragm is interposed because without it there is always a hollow in the rippled surface of the mercury in the center of the box, and no matter how violent the vibrations, the mercury will never meet the wire and complete the circuit. Now, as it is absolutely essential that the wire should occupy this position, the diaphragm is introduced to break the natural arrangement of the waves and produce a crest under the wire.

GENERAL ARRANGEMENT OF SIGNALS.

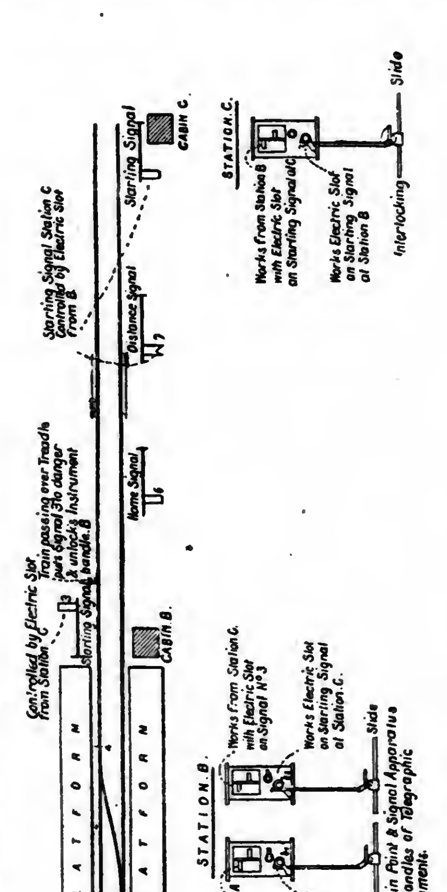


Fig. 11.

SAXBY & FARMER'S IMPROVEMENTS IN RAILROAD SIGNALS.

The general arrangement of the treadle is clearly shown in figs. 1 and 3. A short piece of timber is bolted across two sleepers parallel to the rail. On this timber is fixed a cast-iron box. In this box is pivoted a lever, connected at its short end with the rail. If the rail be of bull-head section the connection is made as in fig. 1, and if it be flat-footed as in fig. 4. The long end of the lever is connected by a link with the mercury box, which in turn is pivoted by a foot-piece to the outer casting. When a train passes over the treadle the deflection of the rail depresses the lever and imparts a greatly magnified fore-and-aft rocking motion to the mercury box, causing the fluid to rush backward and forward, and make repeated and ample contacts with the wire above it. The electric conductors enter through the lower pivot; one is connected through an insulated bush to the contact wire, while the other is fastened to the mercury box, which is itself insulated from the framing. The entire arrangement is most ingenious, while at the same time its simplicity guarantees it from nearly every chance of derangement. A treadle of this kind has been on the London & Northwestern Railway at Kilburn for 18 months without attention, and has registered in Messrs. Saxby & Farmer's works the passage of all the trains which pass that station. In Russia, the line connecting St. Petersburg with Gatschina is provided with these treadles, which have worked perfectly all through the severe winter.

It will be evident that a treadle such as this provides an essential feature in any system in which the passage of a train is to check or supplement the action of the signalman. If a treadle be placed a little distance past each signal, it will send an electric current which may be utilized in various ways. For instance, by means of an electric "slot," the current may put the signal the train has just passed to "danger." The term "electric slot" is intelligible to those acquainted with signaling appliances, but it is not descriptive, and is further not accurate. It arose in this way: when it is desired that a signal shall not be lowered without the concurrence of two signalmen, it is the custom to hold the arm up by two counterweighted levers, each working in a slot in a rod connected to the arm. If either arm be lifted singly it merely moves up in its slot, since the weight of the other is sufficient to hold up the arm, and no effect is produced. But if both be raised the signal-arm drops. Apparatus of this kind has been made in many forms, more or less complicated, but they have all been known as "slots," and now the same name is applied to electric apparatus which is designed to enforce concurrent action from two sources before a signal can be set to "line clear." It is possible that both actions may be electric, or that one may be electric and one mechanical, or even that more than two agencies may be employed in the working of a slot; but, however that may be, either of the agencies can set the signal to "danger" independent of the other. Messrs. Saxby & Farmer's slot is both mechanical and electrical; the former part is worked by the signalman in the adjacent cabin, while the latter is operated either by the treadle to raise the signal to danger, or by the man in the next cabin to allow it to be lowered. The slot is shown in figs. 7, 8 and 9. The wire from the cabin lever is attached to the weighted lever, and works it in the usual way. This lever is connected by a link to the rod which depends from the signal-arm, but the link does not take hold of the rod directly. It is pivoted to a cross-lever or beam, which at its opposite end is connected to the armature of an elec-

tro-magnet. Now, if the armature be against the poles of the magnet, and the current be flowing when the man pulls the wire, the beam will pivot on its right-hand end, and the rod will be raised and the signal lowerәd (fig. 8). But, if there be no current flowing, the center of the beam, as the point of greatest resistance, becomes the pivot, and instead of the rod rising the sole effect of the signalman's effort is to carry the armature away from the magnet and rock the beam to no purpose (fig. 9). Thus, it needs that the current be flowing before the man can lower the signal, and it is further required that the signal lever in the cabin shall be first placed in the danger position in order to bring the armature within reach of the attraction of the magnet. When the signal is down it can be released either by the action of the man who lowered it or by interrupting the electric current. This latter office can be performed by the electric treadle or by the signalman in the next cabin. In the former case, when the train has proceeded (say) 100 yards past the semaphore, it passes over the treadle and sends a current from a local battery (the one which works the slot) through a relay. This breaks the circuit to the slot, and causes the arm immediately to rise to "danger," blocking the line automatically behind the train. But this action does not in any way relieve the signalman, for, if he prefers to let the train work the signal, he must move back his lever to raise the armature before he can give "line clear" again, and thus he has to perform all his accustomed operations.

The treadle has also an office to fulfill as regards the instruments in the cabin, but, in order to avoid complication, we will now describe this in connection with the treadle at the entrance of the section. The train having set the signal behind it, as we have already explained, travels on until it enters the next station, when it passes over another treadle; this raises the corresponding signal, and, at the same time, sends a current into the cabin to unlock the instrument by which the man had given "line clear" to the previous cabin. After he had signaled "line clear" he had moved his handle to "line blocked," where it became securely locked so as to render it impossible for him to send "line clear" until the train had passed over the treadle and released the handle. When this has occurred, the man is free to act as circumstances require. If requested he can send another "line clear" to admit the next train, or he can put over his handle to the opposite side, and thus, unlocking his points and signals, fig. 10 (supposing his cabin to be fitted with interlocking gear), he can permit shunting to be done. But once he has given "line clear," he can do nothing further with his instrument until a train has passed over his treadle; by this means all chance of his forgetting that there is a train in the section is entirely done away with. The train in possession of the line commands the situation, for until it passes out the man at the entrance cannot obtain permission to admit another, and neither can he do so on his own responsibility, for the same current that gives him "line clear" also operates the electric slot, and without it the signal cannot be lowered.

It will be seen that the three parts of the apparatus which we have been describing are more or less independent of each other, that is, one part can be applied without the others. For instance, the treadle can be set to lock the present instruments if a slight modification be made in the latter. Or the electric slot can be operated by the present instruments. Or the slot and the treadle can be used together. Consequently, on existing lines the present apparatus may be preserved and only so much of the new introduced as the circumstances require. Perfect safety is attained by using the whole, for then the signalman is attended, as it were, by an invisible companion who makes no sign as long as matters go right, but on the smallest infraction of the established routine steps in to prevent the error and obliges the man to correct it. If the treadle be dispensed with there still remains the safe-guard that the signal at the entrance of a section cannot be lowered until permission is obtained, and that this permission is revoked and the signal automatically raised before any switching can be done in the section.

Proportions of Locomotive Cylinders.

THE following report was presented to the Master Mechanics' Association at the St. Paul convention by the Committee on Proportions of Locomotive Cylinders, composed of Messrs. Charles Blackwell, F. L. Wanklyn and T. E. Barnett:

Circulars embodying questions bearing on the subject were printed and distributed by your Secretary, and in addition a few copies were forwarded to locomotive superintendents in Great Britain.

Judging by the very small number of answers received, it would appear that the matter is generally considered a subject well understood and not open to further discussion. Much difference of opinion must exist, however, or we should not find in examples of modern locomotive construction such variations in the ratio between tractive power per pound of mean effective cylinder pressure, and weight available for adhesion.

Communications in reply to the circular have been received from the following gentlemen: Mr. J. D. Barnett (Grand Trunk), Mr. J. McGrayel (Des Moines & Fort Dodge), Mr. James Meehan (Cincinnati, New Orleans & Texas Pacific), Mr. Angus Sinclair (*National Car & Locomotive Builder*), Mr. Thomas B. Twombly (Chicago, Rock Island & Pacific), Mr. S. G. G. Copestake (Glasgow Locomotive Works, Scotland), and from Mr. F. W. Webb (London & Northwestern Railway, England).

Mr. Barnett gives the following rule for finding the diameter of cylinder when stroke of piston, mean diameter of driving wheels and weight on same, also boiler steam pressure, are known, viz.: "The square root of the adhesive power, multiplied by the mean diameter of drivers, divided by the mean effective cylinder pressure, multiplied by the length of stroke, weights being expressed in pounds and measurements in inches."

This rule requires the assumption of a co-efficient for adhesion, also of the mean effective cylinder pressure. Mr. Barnett, in the example quoted by him, uses one-fifth as the co-efficient, and states that, as the work to be provided for is the maximum, the mean cylinder pressure should be fully nine-tenths of the initial pressure, which should be not less then 7 per cent. below the full boiler pressure.

Mr. McGrayel states that he adopts practically the same rule, but his experience teaches him that, when using a fraction over 50 per cent. of boiler pressure as the mean cylinder pressure, it is necessary, in order to obtain good results, to use one-sixth as the co-efficient for adhesion in the case of passenger engines, and one-seventh for freight and switch engines.

Mr. James Meehan reports using the same rule, but assumes 90 pounds as the mean cylinder pressure, in conjunction with $\frac{1}{6.17}$ as co-efficient for adhesion.

Mr. Angus Sinclair gives no rule, but states that the proportion of cylinder and the elements of adhesion are subject to a proper ratio, and that any material deviation from the same should be considered a mechanical blunder.

Mr. Thomas B. Twombly uses the rule in Forney's *Catechism of the Locomotive*. "Multiply the total weight on the driving wheels, in tons of 2,000 lbs., by 5, and then by the circumference of drivers, in inches, and divide by 4, the quotient being the cubical contents of each cylinder."

This rule requires some modification to suit the higher boiler pressures now used.

Mr. Copestake uses the same rule, and assumes one-fifth as the co-efficient for adhesion, but uses 63 per cent. of boiler pressure as the mean cylinder pressure. He makes no allowance for wear of tires and takes the diameter of wheels over the tires when new.

Mr. F. W. Webb has no fixed rule, but in ordinary practice adopts a 24-in. stroke of piston, and arranges the diameter of cylinders so that the tractive power at starting, with full boiler pressure, does not exceed the adhesive power under the most favorable circumstances.

Mr. Barnett considers that no deviation should be made from the rule, whether the engine in question be for passen-

ger, freight or switching service. Mr. McGrayel recommends the co-efficient for adhesion to be one-sixth for passenger and one-seventh for freight and switching engines. Mr. Copestake says that the rule should apply to both passenger and freight engines, but in the case of switching engines, the stroke may be longer in proportion to the diameter of the cylinder. Mr. Webb states that he adopts the same rule for both passenger and freight engines.

In reply to question No. 5 of circular, Mr. Barnett states: "When tractive force is in excess of adhesive weight, the results, although not necessarily bad, usually are so, if the engine is in the hands of but an ordinary engineer; as the engine slipping her wheels so easily, is often allowed to do so, causing not only excessive wear of tires and machinery, but also wasting the steam and throwing away the fuel. Nevertheless, within the narrow limits permissible in locomotive design, the larger the cylinder the more economically the engine can be worked in the matter of fuel consumption. This was the opinion and practice of M. Marie, of the Paris & Lyons Railway—and the experiments then carried out (and recorded in the *Proceedings* of the Institute of Mechanical Engineers, May, 1884) with an eight-wheels coupled passenger engine, on mountain service, having cylinders 19¼ x 26 in., wheels 49⅝ in. diameter, with about 58,000 lbs. on drivers, show a consumption of 2.88 lbs. of fuel per indicated H. P. or 3.27 lbs. per actual H. P. and but 30 lbs. of wet steam per H. P. developed. This was achieved with steam at 128 lbs. pressure, cutting off at 19 per cent. of stroke—weight of train 163½ tons, speed 17½ miles per hour, on a continuous grade of 1 in 53½. It is questionable whether such expensive construction is justified where fuel is cheap." He further states: "In other words, an engine having a boiler pressure of 150 lbs., driving wheels of 66 in. mean diameter, and a weight on them of 66,200 lbs., should not have cylinders larger than 17 x 24 in., unless economy of fuel and water is of great importance."

Mr. McGrayel states that when the weight on drivers is less than in the proportion recommended by him, he finds that engines do not give satisfactory results, on account of slipping, which necessitates use of sand, and consequent wear of tires; and when wheels are slipping and are caught on sand, crank pins and side-rods are very liable to be bent or broken.

Mr. Meehan states that the weight on the driving wheels is a point of great influence on the efficiency of the engine, and that the rule quoted by him gives splendid results, as shown by the decreased tire wear. On entering the service of the Cincinnati, New Orleans & Texas Pacific, he found the Northern Division, which is very hilly, with grades of 60 ft. per mile, 6-degree curves, and 27 tunnels, stocked with engines which were of the average character as to weight on drivers. These engines were superseded by others of practically the same cylinder capacity, but with greatly increased weight per driving axle, and as a result, the Roadmaster reports greatly decreased surface wear of rail, and he himself finds the wear of tires much reduced. He believes this has been attained by reduction of slipping, on account of increased weight on drivers.

Mr. Twombly states that engines in which the ratio of weight on drivers to tractive power is above the average, give better results, the wear and tear of machinery being less, and life of tires prolonged.

Mr. Copestake says he generally takes the ratio of cylinder and adhesive power about equal, but if anything, would give an excess, not exceeding 10 per cent., to the adhesive power.

To illustrate the difference in cylinder dimensions, when calculated by the various rules recommended by the gentlemen who have expressed their views on the subject, the following figures are of interest:

Data:
- Passenger engine.
- Stroke of piston, 26 in.
- Mean diameter of driving wheels, 61 in.
- Weight on drivers, 60,000 lbs.
- Boiler pressure, 160 lbs.

Barnett .... $\sqrt{\dfrac{\frac{60{,}000}{5} \times 61}{134 \times 26}}$ = 14.5 in. diameter of cylinder.

McGrayel... $\sqrt{\dfrac{\frac{60{,}000}{6} \times 61}{85 \times 26}}$ = 16.6 in. diameter of cylinder.

Meehan .... $\sqrt{\dfrac{\frac{60{,}000}{6.17} \times 63}{90 \times 26}}$ = 16.2 in. diameter of cylinder.

Twombly ... $\sqrt{\dfrac{\frac{60{,}000}{2{,}000} \times 5 \times 198}{4 \times 26}}$ = 16.9 in. diameter of cylinder.

Copestake .. $\sqrt{\dfrac{\frac{60{,}000}{5} \times 63}{101 \times 26}}$ = 16.9 in. diameter of cylinder.

Webb....... $\sqrt{\dfrac{\frac{60{,}000}{3.7} \times 63}{160 \times 26}}$ = 15.67 in. diameter of cylinder.

Proposed rule...... $\sqrt{\dfrac{\frac{60{,}000}{4} \times 61}{136 \times 26}}$ = 16.1 in. diameter of cylinder.

In the consideration of this subject, one has to deal with two indefinite quantities, namely, the mean effective steam pressure in the cylinders and the co-efficient of adhesion, and both of these have to be assumed before any calculation can be proceeded with.

The first, or mean effective cylinder pressure, is of course, primarily governed by the boiler pressure, and is secondarily subject to alteration by point of cut-off and speed—it is assumed that the engine is worked with the throttle wide open, and that the steam passages are of proper dimensions, otherwise the pressure will be influenced by these causes.

Few railroads are free from grades which necessitate engines being worked, to a greater or less extent, nearly up to their ultimate capacity, and in the event of starting on such grades, as well as from stations generally, of being worked full power; hence it appears proper that the mean effective cylinder pressure should be placed sufficiently high to cover such cases, and your Committee are of opinion that 85 per cent. of the boiler pressure be considered the mean effective cylinder pressure in the formula.

The second indefinite quantity, or the co-efficient of adhesion, varies as the condition of the surface of the rail changes, and, according to Molesworth, from $\frac{1}{3.7}$ to $\frac{1}{11.2}$, the former being due to a perfectly clean and dry rail; the latter to a slightly moistened or frosted rail. In different parts of the world it is doubtless possible to find places where the average co-efficient for the year will vary to such an extent as to warrant special allowance being made to suit the circumstances; but in the United States it may be safely stated that exceptional climatic peculiarities, sufficient to justify any material deviation from a standard rule, do not exist.

As passenger engines are worked so as to produce a mean effective cylinder pressure of 85 per cent. of the boiler pressure for a very limited fraction of their total mileage, it would appear not improper to use the co-efficient one-fourth, or that due to a dry rail, for calculating the proportions of passenger engines.

Freight engines being worked to their ultimate capacity to a very much greater extent than passenger engines, it would be consistent to increase the co-efficient to say $\frac{1}{4.25}$, and in the case of switching engines, generally worked full stroke, a co-efficient of $\frac{1}{4.5}$ would be required to obviate the excessive use of sand, to prevent slipping on the more or less greasy rail generally encountered in yards where this class of engine is employed.

An inspection of the tabular statement herewith, shows that among engines of recent construction very great variations in their relative tractive power and adhesive weight exist.

In the case of American passenger engines, and using the formula recommended by your Committee, it is found that the New York, Lake Erie & Western Mogul engine, built by the Baldwin Company, has an excess of adhesive weight of 26,600 lbs., or 38.7 per cent.

The eight-wheeled engine built by the Mason Works shows an excess of over 12,400 lbs., or 22.3 per cent; while the Lake Shore and the Old Colony eight-wheeled engines are deficient in the same respect to the extent of 6,500 lbs., or 9.2 and 9.5 per cent. respectively.

Among foreign passenger engines, the Belgian State locomotive has an excess of adhesive weight of over 20,000 lbs., or about 46.5 per cent.; the New South Wales Mogul an excess of nearly 16,000 lbs., or 25.2 per cent.; while the Great Northern express engines, with 91½-in. driving wheels, are deficient to the extent of 12,600 lbs., or over 24.8 per cent.

Among freight engines of American build, the variations are not so great. The Union Pacific Wootten consolidation engine has an excess of 18,900 lbs., or 21.8 per cent., the Baltimore & Ohio Mogul an excess of 12,500 lbs., or 16.7 per cent.; while the Baldwin "Decapod" shows a deficiency of 18,300 lbs., or 12.5 per cent.

Of foreign freight locomotives, the six-wheels coupled engine of the Great Eastern Railway has an excess of 16,200 lbs., or 24.6 per cent., while the Dübs consolidated engine, built for Brazil, has a deficiency of 14,900 lbs., or nearly 14.3 per cent.

Of switching engines, the Brooks six-wheeled switcher has a deficiency of 13,900 lbs., or 17.4 per cent.

Your Committee recommend for general purposes, the use of the following formula:

$$\frac{d^2 \times S \times P \times 0.85 \times C}{D} = W$$

D = Diameter over tires when half worn.
d = Diameter of cylinder.
S = Stroke of piston.
P = Boiler pressure.
W = Weight on driving wheels.

$$C = \text{Co-efficient for adhesion} \begin{cases} \frac{1}{4} & \text{for passenger engines.} \\ \frac{1}{4.25} & \text{for freight engines.} \\ \frac{1}{4.5} & \text{for switching engines.} \end{cases}$$

Should extreme economy in fuel and water consumption be considered imperative, and of greater importance

CYLINDER CAPACITY AND ADHESIVE WEIGHT OF VARIOUS MODERN LOCOMOTIVES.

Accompanying Report on "Proportions of Locomotive Cylinders."

PASSENGER ENGINES.

NAME OF RAILROAD OR MAKER.	Cylinder. Diam.	Cylinder. Stroke.	Driving wheels, diameter over new tires.	Tractive power per 1 lb. M. E. C. P.	Boiler pressure.	Weight on driving wheels. Actual.	Weight on driving wheels. Calculated.	Weight on driving wheels. Excess.	Weight on driving wheels. Deficiency.
	In.	In.	In.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Belgian State	17½	24	79	90.8	142	64,300	43,900	20,400	....
New York Central	17	24	70	101.3	145	52,200	49,800	2,400	....
Chicago, Burlington & Quincy	17	24	69	102.8	140	53,600	48,900	4,700	....
Chicago, Rock Island & Pacific	17	24	66¼	105.0	150	52,500	53,300	....	800
Brooks—1883	17	24	67	105.9	140	48,000	50,400	....	2,400
Great Northern (England)	18½	28	91½	106.6	140	38,100	50,700	....	12,600
New York, Providence & Boston	18	24	72	110.3	180	72,000	67,500	4,500	....
Northern Pacific	17	24	62	114.6	140	51,400	54,500	....	100
Chicago, Burlington & Quincy	18	24	69	115.2	140	54,500	54,800	....	300
Lake Shore & Michigan Southern	18	24	69	115.2	180	64,000	70,500	....	6,500
Old Colony	18	24	69	115.2	175	61,700	68,200	....	6,500
Mason	18	24	68	116.9	140	68,000	55,600	12,400	....
Cincinnati, New Orleans & Texas Pacific	18	24	68	116.9	140	60,000	55,600	4,400	....
Chicago, Rock Island & Pacific	18	24	66¼	117.4	150	55,000	59,600	....	4,600
Caledonian	19	26	78	120.3	160	68,200	65,400	2,800	....
Glasgow & Southwestern	18¼	26	73½	120.3	140	62,000	57,300	4,700	....
Great Eastern	18	24	64	124.4	140	65,000	59,200	5,800	....
Grand Trunk (tank)	17	24	56	127.3	140	57,200	60,600	....	3,400
Union Pacific	18	26	63	138.1	140	61,000	65,700	....	4,700
New South Wales	18	26	60½	142.8	130	79,000	63,100	15,900	....
Lehigh Valley	20	24	68½	143.3	130	73,400	63,100	10,300	....
New York, Lake Erie & Western	20	24	68	144.4	140	95,300	68,700	26,600	....
Philadelphia & Reading	21	22	68½	144.8	140	71,900	68,900	3,000	.
Lehigh Valley	20	24	62	158.7	160	90,000	86,300	3,700	....
FREIGHT ENGINES.									
Great Eastern (England)	17½	24	58	130.1	140	82,000	65,800	26,200	....
Brooks—Mogul	18	24	55¾	143.3	140	72,500	72,500	....	....
Baltimore & Ohio	19	24	60	148.1	140	87,400	74,900	12,500	....
Brooks—Ten-wheeler	19	24	55¾	159.7	140	73,100	80,800	....	7,700
Canadian Pacific	19	22	51	160.5	160	90,900	92,800	....	1,900
Union Pacific	20	24	58	171.4	140	105,600	86,700	18,900	....
Louisville & Nashville	20	24	51	193.9	150	97,000	104,700	....	7,700
Norfolk & Western	20	24	50	197.9	140	96,000	100,100	....	4,100
Pennsylvania	20	24	50	197.9	140	100,600	100,100	500	....
Northern Pacific	20	24	49	202.1	140	97,000	102,200	....	5,200
Dübs (for Brazil)	20	24	48	206.5	140	89,500	104,400	....	14,900
St. Gothard	20.47	24	46	226.0	149	114,000	122,000	....	8,000
Southern Pacific	21	36	57	286.0	130	121,000	134,300	....	12,700
Decapod (Baldwin)	22	26	45	289.3	140	128,000	146,300	....	18,300
Johnston's (Four-cylinder)	22	18	57	314.6	140	140,000	158,800	....	18,800
SWITCHING ENGINES.									
Brooks	17	24	48	149.2	140	66,000	79,900	....	13,900
Union Pacific	18	26	52	168.5	140	87,700	90,200	....	2,500
Norfolk & Western	19	24	50	178.6	140	94,900	95,600	....	700

NOTE.—In calculating weight for adhesion, the M. E. C. P. is assumed to be 85 per cent. of boiler pressure, and the co-efficient for passenger, freight and switching engines, $\frac{1}{4}$, $\frac{1}{4.25}$ and $\frac{1}{4.5}$, respectively.

than additional cost of superheaters and steam-jacketed cylinders and maintenance of same, a considerable increase of cylinder power would be admissible, so as to allow the average work to be performed with a correspondingly earlier cut-off and greater ratio of expansion.

The unsatisfactory results, however, obtained with the ordinary link motion from the wire-drawing of steam, when cut off much earlier than at 25 per cent. of the stroke, point to the desirability of using some other type of valve motion, when the extreme practice above referred to is contemplated.

THE NEW WARSHIPS.

At the Navy Department in Washington, on August 8 bids were opened for the building of three cruisers—No. 1, the *Newark*, and Nos. 4 and 5—and two gunboats—Nos. 3 and 4. The designs for these vessels were described, and those for the cruisers illustrated, in the Journal for July, pages 311–315.

Under the terms of the notice given by the Department the proposals were to be in three classes, as follows: Class 1, for the construction of the hull and machinery, including engines, boilers and appurtenances, complete in all respects, in accordance with the plans and specifications provided by the Secretary of the Navy. Class 2, for the construction of the hull and machinery, including engines, boilers and appurtenances, complete in all respects, in accordance with the plans and specifications provided by the contractor. But no such proposal was to be considered unless accompanied by full and complete plans and specifications of such hull and machinery, and a satisfactory guarantee of the results of the same if adopted. Class 3, for the construction of the hull according to the plans and specifications provided by the Secretary of the Navy, the contractor to put in engines, boilers and appurtenances of any design which he may consider more suitable than those called for by said plans and specifications, not to exceed, however, in weight, nor in the space to be occupied, that allotted in said plans and specifications. But no such proposal was to be considered unless accompanied by full and complete plans and specifications of such proposed engines, boilers and appurtenances, and a satisfactory guarantee of the results of the same if adopted.

The bids received by the Department were as follows:

Cruiser No. 1.—*Newark*:	
Cramp & Sons, Philadelphia, Class 3	$1,248,000
Cruisers Nos. 4 and 5:	
	Each.
Cramp & Sons, Class 1	$1,410,000
Cramp & Sons, Class 2, with 3-in. protective deck	1,325,000
Cramp & Sons, Class 2, with 4-in. protective deck	1,350,000
Cramp & Sons, Class 3	1,405,000
Union Iron Works, San Francisco	1,428,000
Gunboats Nos. 3 and 4:	
Cramp & Sons, Philadelphia, Class 1	495,000
N. F. Palmer, Jr. & Co., New York, Class 1	490,000

The three cruisers must be completed within 24 months and the two gunboats within 18 months from the time of signing the contract.

N. F. Palmer, Jr. & Co. represented the yard of John Roach & Sons, at Chester, Pa., and, for the machinery, the Quintard Iron Works, New York.

The awards made by the Navy Department under these bids were announced August 15, and were as follows:

Cruiser No. 1—*Newark*—to Cramp & Sons for their bid, $1,248,000.

Cruiser No. 4 to Cramp & Sons under their bid of Class 2 (they to furnish plans) for $1,350,000.

Cruiser No. 5 to the Union Iron Works, San Francisco, for $1,428,000.

Gunboats Nos. 3 and 4 to N. F. Palmer, Jr. & Co., for $490,000 each.

In submitting the bids to the President, the Secretary of the Navy writes: "I have compared with the aid of the Chiefs of the Bureaus of Construction and Steam Engineering, the various plans, and in accordance with their advice I respectfully recommend that one ship be built upon the Department's plans, and that for the other one the bid of William Cramp & Sons, for $1,350,000 be accepted. With this later bid original designs are submitted. These plans differ somewhat from those of the Department. The proposed ship is larger in tonnage, with thicker protective deck, lighter in construction in parts and stronger in others. A cheaper mode of construction is adopted in some respects, but none but approved practices are employed. The hull designed by the Bureau is more expensive to build, but which is the better on the whole no one can, at the present time, safely predict. I think there is every advantage in building both, and I so recommend."

We may here briefly repeat that the *Newark* is to be a cruiser with a maximum speed of 18 knots. Her main battery is to consist of twelve 6-in. breech-loading rifles, all on center-pivot mounts. She is to have twin screws, to be 310 ft. long on the water line, 49 ft. 1¾ in. extreme breadth, 18 ft. 9 in. mean draft. She is to have machinery of 6,000 I. H. P. with natural draft and 8,500 with forced draft. She is to have a bark rig spreading 1,200 ft. of plain sail. This vessel is to have a double bottom extending through 129 ft. of the length.

The description of the twin cruisers is in most respects similar in every detail with that of the *Newark*. The exceptions are that they are to have machinery of 7,500 I. H. P. under forced draft. The speed is to be 19 knots, and the rig that of a three-masted schooner spreading 5,400 square feet of sail. Their armament is also to consist of main batteries of twelve 6-in. breech-loading rifles.

Gunboats Nos. 3 and 4 are to be 1,700 tons each. They are twin-screw vessels, having a length on the load line of 230 ft., an extreme beam of 36 ft. and a displacement at 14 ft. of 1,700 tons. The machinery is estimated to indicate 2,200 H. P. with natural and 3,300 with forced draft. There are to be two independent compound engines placed in separate compartments. The cylinders will be 29 in. and 52 in. diameter and 30-in. stroke. The speed is stated at 16 knots.

Should the vessels on trial fall below the required speed, the contractors are to forfeit $50,000 for each quarter knot deficient; on the other hand, they will receive $50,000 over the contract price for each quarter knot gained over the required speed.

FIRST-CLASS TORPEDO-BOAT.

The Navy Department has issued a call for bids for a first-class torpedo-boat, complete with the exception of torpedoes and their appendages. The boat must be of modern design, must be built of steel and provided with twin screws and with engines which shall give the highest attainable speed, 22 knots being fixed as a standard. The cost of the boat is not to exceed $90,000, but the builder will receive a premium if the speed is found to exceed 22 knots. Bidders must submit full drawings and specifications, with complete description, showing the kind, power and economy of the engines and boilers to be used; also all the arrangements and fittings of the vessel. Bids must be all in by noon of Tuesday, November 1 next.

THE ARMORED BATTLE-SHIP.

The Secretary of the Navy has appointed a board of officers, consisting of Chief Constructor T. D. Tilson as senior member and President, Engineer-in-Chief George J. Melville, Captain George Brown, Assistant Naval Constructor Francis T. Bowles and Assistant Naval Constructor Lewis Nixon, to convene at such time and place as may be designated by the presiding officer of the board for the purpose of examining and carefully considering the plans for the armored battle-ship furnished by the Barrow Shipbuilding Company, and reporting to the Department the probable cost, exclusive of armament, of constructing such vessel in accordance with said plans, the armor to be furnished by the Bethlehem Iron Company, of Bethlehem, Pa., under the contract of June 1, 1887.

In accordance with the terms offered by the Department, the Barrow Shipbuilding Company will receive $15,000 for the design for this ship. The further sum of

$6,900 has been agreed upon as the price to be paid for full working drawings and plans for the construction of the vessel.

LIST OF SHIPS AUTHORIZED.

We repeat here a table showing the present condition of matters in relation to the vessels which are to form the new Navy, and the construction of which has so far been authorized by Congress:

MONITORS:	Tons disp.	Chief battery.	Conditions.
Amphitrite	3,800	4 10-in.	To be completed.
Monadnock	3,800	4 10-in.	" "
Terror	3,800	4 10-in.	" "
Miantonomah	3,800	4 10-in.	" "
Puritan	6,000	4 10-in.	" "
BATTLE-SHIP:			
Armored battle-ship	6,000	2 12-in. 6 6-in.	Designs adopted.
CRUISERS:			
Atlanta	3,000	2 8-in. 4 6-in.	In commission.
Boston	3,000	2 8-in. 4 6-in.	Nearly ready.
Chicago	4,500	4 8-in. 6 6-in.	Nearly ready.
Charleston	3,730	2 10-in. 6 6-in.	Building, Union Iron Works.
Baltimore	4,400	4 8-in. 6 6-in.	Building, Cramp & Sons.
Newark	4,000	12 6-in.	Contract let, Cramp & Sons.
No. 4	4,000	12 6-in.	Contract let, Cramp & Sons.
No. 5	4,000	12 6-in.	Contract let, Union Iron Works
Armored cruiser.	6,000	4 10-in. 6 6-in.	Designs under consideration.
GUNBOATS:			
Dolphin	1,500	1 6-in.	Complete.
No. 1	1,700	6 6-in.	Building, Union Iron Works.
No. 2	900	4 6-in.	Building, Columbian I. Wks. Balt.
No. 3	1,700	6 6-in.	Contract let, Palmer & Co.
No. 4	1,700	6 6-in.	Contract let, Palmer & Co.
TORPEDO-BOATS, ETC.:			
Stiletto	.....	....	Purchased.
First-class, No. 1	.....	....	Bids called for.
Pneumatic dynamite gunboat	....	3 P. D.	Building, Cramp & Sons.

The total number of vessels whose building is authorized is thus 5 monitors, 1 battle-ship, 9 cruisers (one heavily armored), 5 gunboats, 1 pneumatic dynamite gunboat and 2 torpedo-boats; a total of 23 vessels, large and small.

THE "ATLANTA'S" GUN-CARRIAGES.

The report of the board (Captain F. M. Ramsay, Commander C. F. Goodrich, Naval Constructor Philip Hichborn, Lieutenant A. R. Conden and Assistant Naval Constructor Lewis Nixon) to the Secretary of the Navy on the guns and gun-carriages of the *Atlanta* is dated July 29, and is as follows:

In obedience to the Department's order of July 22, the Board convened on board the *Atlanta*, Newport, R. I., July 25, and made a careful examination of the ship, guns, carriages and fittings and of the damage sustained during the recent target practice, as reported by board of officers ordered by the commanding officer of the *Atlanta*. The board proceeded to sea on the morning of July 25, but were prevented from firing the guns by a heavy fog which prevailed throughout the day. The ship was again taken to sea on the morning of July 27 and the guns were fired. No deficiencies were noted in the guns themselves, other than a slight sticking of the breech plug in 6-in. B. L. R. No. 5 (this disappeared during the firing), some difficulty in the management of the lock 6-in. B. L. R. No. 4, caused by slight upsetting of the firing-pin, and the bending of the extractor in 6-pounder R. F. No. 5.

The recoil and counter-recoil of the 8 and 6-in. guns were easy and satisfactory, except at the second fire of the 8-in. B. L. R. No. 1, when the gun remained in. (This was readily run out with a tackle.) The action of the carriage of 8-in. B. L. R. No. 1, at the first fire, was due to want of strength in the clips and clip circles, and at the second fire to want of sufficient bearing and securing of the deck socket. It is believed that had the deck socket held the carriage would not have been disabled by the giving way of the clips. The training gear, steam and hand, was uninjured; the gun was readily trained when run out to place. The action of the after 6 in. shifting gun No. 4 was satisfactory, notwithstanding that the front clips had a play of half an inch. The action of the broadside carriages of 6-in. guns Nos. 5 and 18 was satisfactory, except the breaking of clips, the starting of the copper rivets in the clip circles, and the wood screws in the training circles. It is believed from the action of the carriage of 6-in. B. L. R. No. 5, when the clips were removed, that the carriages can be safely used without clips. The clips, however, give additional security and steadiness to the carriage, and assist the pivot and socket in bearing the shock of the discharge. The firing of the 6-pounder R. F. guns developed a weakness in one leg of the cage-mount of No. 4, due to imperfect workmanship, and also the necessity of locking nuts on the bolts that secure the mounts to the ports. The tower mounts of the 3-pounder R. F. guns are unsatisfactory. They cannot be moved with facility; the line of sight of the gun is obstructed at ranges beyond 1,600 yards, and the guns cannot be safely used as now fitted. For this reason 3-pounder R. F. No. 3 was not fired. The tripod mounts of the 1-pounder R. F. guns need stronger holding-down arrangements. The tower mounts of the 47-millimeter R. C. are like those of the 3-pounder R. F. guns, and have the same defects. The shelf and the trolly mounts of the 37 mm. in the tops are satisfactory. Careful observation of the effect of the firing upon the hull of the vessel failed to develop any damage other than the breaking of the cast-steel port sills and the starting of some light woodwork. The shock of discharge was slight on the berth deck, and observers there were unable to observe which 6-in. gun had been fired. The deck, hull and fittings, with the exception of the port sills, hinges to superstructure doors and vegetable lockers and some of the light woodwork, have every appearance of strength and ability to endure the strain of continuous firing of the guns. The blast of the forward 8-in. gun, when fired abaft the starboard beam, will not permit the crews of the starboard 3-pounder R. F. and 1-pounder R. F. to remain at their guns. When the after 8-in. gun is fired forward of the port beam the crews of the after 47 mm. R. C. and of the port after 1-pounder R. F. cannot remain at their guns. When the forward 6-in. shifting-gun is fired on the port bow, or directly ahead, the crew of forward 8-in. gun cannot remain at their places. When the after 6-in. shifting-gun is fired on the starboard quarter, or directly aft, the crew of the after 8-in. gun cannot remain at their gun. The inability to fire parts of the secondary battery under certain conditions is due to the great arc of fire given to the 8-in. guns. This can hardly be called a defect. It is thought that a screen can be placed between the 8 and 6-in. guns, which will enable them to be worked together forward or aft.

The pivot socket of the 8-in. carriage should have a broader bearing surface and should be rigidly bolted to the steel deck and to the framework of the ship in such manner as to distribute the strain over a larger area. The clips and clip circles of the 8-in. and 6-in. carriage should be made of steel. The clips should have larger bearing surfaces, and should be shaped to fit the circle. The circle should have double flanges and be bolted (not riveted) on each flange to the steel deck. There should be no appreciable play between the clips and the circles. All bolts used in the battery fittings should have the nuts locked.

The clip rail of the tower mount should be altered to fit the mount. This change will make the compressors effective and allow the guns to be used with safety.

The port sills should be replaced by heavier sills made of the best quality of malleable cast-steel.

The plan of testing the hull, guns and fittings of the *Atlanta*, arranged by the Board, contemplated a more extended use of the main battery, but the weakness developed in the port sills and in the sockets of the 8-in. carriages rendered further firing inadvisable.

The English Naval Review.

(From the London *Engineer*.)

WITH all that took place at the great Naval Review, held at Spithead on Saturday, July 23, the world has been made more or less familiar by the daily press. It would be waste of time did we attempt to tell the story over again. We have failed, however, to find in the columns of our contemporaries certain deductions which admit of being drawn from the spectacle. No doubt they did not suggest themselves to the non-professional mind. We propose to fill the gap and direct attention to points connected with the construction of warships, which have not, as we think, received the attention they deserve. Let it not be supposed, however, that we are going to fight over again the battle of ships and guns, or to discuss the relative merits of various types of armor. Nor shall we say anything of stability, or ramming, or steering powers. The questions we propose to discuss have indeed little or nothing to do with any of these things. They have, as a rule, been entirely ignored. To see the modern warship anchored at Spithead sufficed to force these questions on the attention of any thoughtful man, who, knowing something of naval warfare and the conditions under which it will be carried on, was at the same time unwedded to any particular system of construction or method of fighting.

Let us consider what is the purpose for which such a ship as, let us say, the *Inflexible* has been constructed. This vessel has a displacement of nearly 12,000 tons, her main engines indicate between 7,000 and 8,000 H. P., and she carries 10 guns, four of them very nearly the heaviest afloat. She is besides fully fitted with torpedo gear. The whole object and purpose of this vessel is to carry her 80-ton guns and torpedoes from place to place as they may be required. She has considerable speed, first, because she may at any time be wanted in a hurry in some special place; secondly, that if an enemy tries to run away she may be able to catch her; and lastly, that if she has herself to run away, being attacked by an overwhelming force, she may be able to make the attempt with some prospect of success. The be-all and end-all of her existence is, however, to carry 4 mighty guns, and to enable them to be discharged with as much effect as possible against an enemy. Regarded from this point of view, it will be seen that everything becomes subordinate to the guns, and, of course, the torpedoes. Now it is impossible, we think, to look at such a ship without feeling that everything is not subordinate to the guns, but that, on the contrary, the guns are subordinate to many things. Let us for the moment leave torpedoes on one side, and consider what would be the best way to make the guns efficient. At the outset it appears that it is a policy of doubtful wisdom to put all four of such extremely expensive eggs in one basket, and that four ships, each carrying one 80-ton gun would be better than one ship carrying four guns of this weight. This point, however, we shall not urge; but, retaining our four guns, does it not appear that these weapons, if to be carried in turrets, ought to be so carried that the ship will present the least possible mark to the enemy, and that the structure of the ship above the water-line should be as simple and straightforward as possible? In one word, Ericsson's *Monitor* above water supplies the *beau ideal* of what a warship carrying heavy guns ought to be. We say "above water" advisedly, because there were many and grave defects in the underwater portion of the *Monitor* type, as elaborated in the United States, which should not be copied. The perfect warship, then, would be a vessel with her upper deck not raised many feet above the water-line, and nothing projecting above that deck save the two turrets carrying the guns and the funnel. If it be conceded that the object of the life of a warship is to fight, and that fighting involves the carrying of heavy guns from place to place, then it will be admitted that our definition of the perfect warship is sound. Of course if our proposition is disputed on the ground that in a warship everything is not subordinate to guns, a large question for discussion may be opened. Let us suppose for the moment that the soundness of our proposition is granted, and see how far the modern turret ship complies with it. It was only necessary to pass down the lines at Spithead to see that such ships as the *Devastation, Inflexible, Ajax*, etc., do not comply with it at all. We have in them first the low deck and the turrets, but above these rises a huge structure, weighing a great many tons, and employed as a promenade deck, if we may so use the words. In addition, there are dozens of great ventilators, needed to take foul air out of the ship and pass air into her, to say nothing of supplying her furnaces. Of boats we need not speak. They may, perhaps, be regarded as necessary evils. It is quite impossible for those who have not been on board a modern turret-ship to fully realize what a mass of top-hamper, as a sailor would say, she carries, but a very fair idea of it could be got by those who kept their eyes open at the review. May we ask, what would become of all this top-hamper in a naval engagement. It has often been stated that deck-houses, to use an euphuism, would all be blown to bits during the first few minutes, and that their loss would entail no trouble. This we venture to doubt. That the hurricane deck, etc., would be smashed up by quick-firing shell guns in a very short time is quite true; but can anyone assert that the consequences might not be disastrous? We may take it for granted that no lives would be lost, for the crew would be withdrawn below when the ship went into action; but is it not possible that a turret might easily be rendered useless by a mass of heavy ironwork falling on and jamming it? But this is not all. If the great ventilators are essential to the working of the ship, what will occur when these ventilators are crushed up and practically ruined? The funnels are to a certain extent protected by armor-plating near the base, but above they are easily destroyed. What would be the result of this destruction? The furnaces depend for their draught, it may be urged, on fans—not on a chimney. Quite so; but all the fans in existence could not help a ship if her funnel was choked below with fragments of itself dropped from above. Naval architects do all that lies in their power to make a ship impregnable as far as the hull is concerned; and they then build up on the top of this hull a mighty structure of decks and houses and ventilators and funnels, and we know not what, and think that all is well. This view we cannot take. We believe that in this much neglected superstructure lies an important element of danger, and that the truth has not been recognized before, simply because attention has been diverted altogether to other aspects of the warship question.

We have no doubt but that it will be urged that these deck structures are essential; that they cannot be done without, that they are needed to provide accommodation for the crew and as means of navigating the ships. This is quite possible; but, so much the worse. It may be pointed out, however, that by saving the weight of these things the ship might be made to float a little higher in the water, and so provide a little more accommodation for the crew below. It does seem strange that in a ship of 12,000 tons it is impossible to find room for 450 men without resorting to deck-houses, and the unprejudiced mind begins to think that if naval architects consulted with naval men a little more it might be possible to arrive at a compromise which would end in reducing the intolerable amount of top-hamper now being carried, and would secure means of ventilation without the necessity for the vast wind sails which now disfigure our men-of-war, especially the fast ships So much for one lesson taught, we think, by the review. Now for another.

Those who were fortunate, or shall we say unfortunate, enough to see the review from the great Indian trooper *Tamar* saw that she was steadily followed from Southampton Docks by a craft which, looked on from the great height of the *Tamar's* taffrail, more resembled in hue and shape, but certainly not in speed, a huge slug than anything else. This was the submarine torpedo-boat, the *Nordenfelt*, which has already been pretty fully described and illustrated in our pages. The *Tamar* got out of dock late, as she had to give way to the *Orontes* and the *Himalaya*, and she did not waste time in steaming to Portsmouth. She is a fast ship too, and returning to Southampton in the evening, she very easily and hand-

somely beat the *Orontes*. But on the run down to Portsmouth the *Nordenfelt* just kept the position with regard to the troopship that she liked best. She was not nearly submerged; yet the target she presented was extremely small. Coming bows on 200 yards or so in the wake of the *Tamar*, little could be seen but an upheaved mass of water. Unlike torpedo-boats, which, when going at speed, lift their bows out of the sea, the *Nordenfelt* keeps on an even keel, and raises in front of her a curious wave, which is rifle proof and probably proof even against machine-guns, because the solid mass of water deflects bullets upwards at such an angle that they clear the hull. The *Nordenfelt* appeared to be the very incarnation of destructive power. There was not one of the magnificent and costly men-of-war reviewed by her Majesty that could do anything to avert destruction by the *Nordenfelt*, if this destruction were contemplated, save take to her screws as fast as she could. At a distance of a mile the boat, when *à fleur d'eau*—that is to say, with only her little conning-tower out of the water—is invisible; when within a couple of hundred yards we do not believe she would be detected, save by chance, if there was a little sea on; at night, the chances of her being found by torpedo guard-boats would be extremely small. She could thus run quite close up to a ship without availing herself fully of her submarine powers, and her chances of getting away unhurt, after discharging her torpedoes, would be very good. But she could approach within a mile of an ironclad at anchor; take her bearings accurately and then go down and proceed under water until she had run the requisite distance—she could, if in any doubt, come nearly to the top for a moment to permit the steersman to see where he was precisely, and then go down without being detected, or, if detected, injured—and immediately afterward deliver a blow which would send a great ironclad to the bottom. The *Nordenfelt* has rendered, we think, naval operations against forts and harbors nearly impossible. No commander dare lie near a harbor from which a submarine boat could be despatched to blow up his ship. The one chance remaining is that ships may be rendered torpedo proof, and how that is to be done remains to be seen.

During the review the *Nordenfelt* lay near the *Tamar*. In the evening she weighed her anchor and steamed back to Southampton, where, we understand, Government trials will be carried out with her in a short time. Events follow each other with rapidity in the Nineteenth Century. We have already seen the British Navy entirely reconstructed on principles which were not dreamed of in 1856. It is possible that a very few years will suffice to see it remodeled once more, and our readers may rest assured that, if this be the case, the influence of the *Nordenfelt* will be manifested in that remodeling.

The New Light Artillery Guns and Carriages.

(From the Springfield, Mass., *Republican*.)

A MODEL for a machine-gun carriage has just been completed at the United States Armory in Springfield. The carriage is the invention of Colonel Buffington, as was the artillery carriage adopted by the Government last year, and is ingeniously constructed, promising to revolutionize this feature of modern warfare. The carriage furnishes a complete protection to the gunners, and will render the men who are working it as safe as they would be inside an iron-clad. Contrary to what would naturally be expected from such a contrivance, it will present a graceful and imposing appearance. The features of the carriage are a huge semi-circular concave shield rising from the axle, a steel apron, which drops from the axle to the ground, a steel disk which covers each wheel and the hollow iron axle and trail The most noticeable thing about the carriage is the great half-luna shield of armor metal, which rises from the axle, and through which the muzzle of the gun projects. The front of the axle is curved on a line with a great circle passed through the sphere of which the shield is a quarter. The half-shield is made of the toughest steel, 0.15 in. in thickness, and is bolted to the front edge of the axle. This is of sufficient resistance to afford protection from any bullet shot from a distance of 200 yards or over, and a machine gun cannot be used to advantage in closer combat. A circular hole is cut in front of the shield, which will allow the muzzle of the gun to turn as far in any direction as it could if the shield were not used. Of course, if the shield were left with this aperture uncovered the gunner would still be exposed, but to remedy this two large circular shields, about the size of the ordinary Greek shield, are riveted one on each side of the aperture in the main shield, so that they can be made to revolve on the rivet which fastens them. A hole is cut in the edge of each of these smaller shields so that it covers the gun all but about an inch on each side. Thus, when the gun is raised or lowered, the shields revolve and the aperture is still covered. The smaller shields are also made to run in a track to allow for the movements of the gun from side to side. No weight is carried on the muzzle, and the freedom of the sweep is not in the least impaired.

It was said that the outside or smaller shields cover the gun excepting about an inch at each side. This allows for the sighting of the gun, but, at the same time, renders the protection to the gunner incomplete, so that a thimble is made to slip over the muzzle of the gun inside the shield. This thimble will carry a flange on it sufficiently wide to make up for the space left open by the smaller shields, and it will have in it a slot, which can be turned toward and away from the sight, as occasion requires. The axle is what is called a box-beam axle and is hollow; it thus furnishes room for a closet on each side, which are shut by steel doors. These, with a similar closet in the hollow steel trail, gives room for 1,200 cartridges, or as many as are fired in an ordinary battle. The axle, although hollow, is stronger than a common steel and wooden axle. A T-axle runs along on the bottom of the box-beam axle, and a steel apron is fastened to this which reaches to the ground, but can be swung back and strapped to the trail when the carriage is drawn by the limber. The apron is made of the same metal as the shields. The wheels will also be covered by disks of the same metal, and when these are all in use the gunner will be behind a complete armor. Any or all of these protections can be taken off and laid aside at will. The large shield being spherically curved, a ball which strikes it in any place but the center will be made to glance off, and if it strikes the center it will come in contact with two steel plates made by the lapping of the two shields, unless it strikes the muzzle of the gun. The carriage can be used with any machine gun. The models of the shields are made of wood, but the trail and body are of steel. A steel shield will be made as soon as Colonel Buffington finds a kind of steel which is tough enough. It is reported that a Kentucky blacksmith has discovered a new way of tempering metal and that he will present the method to the Government. Colonel Buffington is waiting to see what it turns out to be. The lines of the whole carriage are symmetrical and it reminds one, with its dome shaped shield, of a Roman chariot.

The Captive Kite-Balloon.

(E. Douglas Archibald, in *Nature*.)

IT has always been an objection to the extensive use of captive balloons for scientific or military purposes, that a wind of moderate strength suffices not merely to depress them considerably from the vertical, but to cause them to jerk, rotate and oscillate vertically and horizontally in such a manner as to render them either partially ineffective or totally useless.

During the recent military manœuvres at Dover, it was stated that the captive balloon under the charge of Major Templer was not allowed to ascend beyond the shelter of the snrrounding downs, owing to the strong wind then prevailing. It was thus *hors de combat* as far as the enemy was concerned, and this seems to be a common experience of military balloonists.

The jerking, as a balloon after a freshening of the wind suddenly reaches the end of its tether, is, I am told by an

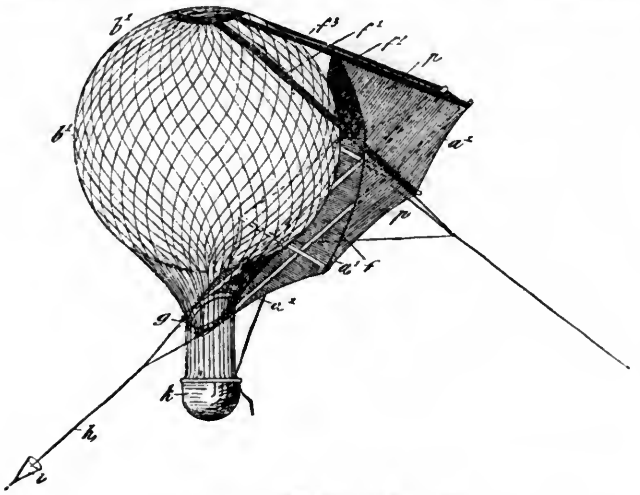
experienced member of the Balloon Corps, very trying to the nerves, while the rotation on its axis is a serious obstacle to steady observation.

The depression of a captive balloon in a wind of any sensible strength is also more than most persons would imagine, and as the velocity of the wind generally increases with the height (very rapidly for the first few hundred feet), while the buoyancy of the balloon, owing to several causes, diminishes, this condition becomes more pro..ounced at the higher levels.

The depression is obviously due to the fact that a captive balloon, as at present employed, can only be secured at its *base*, and thus the normal component of the wind is resolved in a downward direction, pressing the balloon toward the earth. If the fastening could be made two-thirds of the way up its side, this normal component could be resolved in an upward direction, and utilized so as to add to the elevating power of the balloon. The fragile nature of the balloon fabric, however, renders it impossible to do this except by interposing a kite-surface between it and the wind.

All the preceding defects are remedied and several positive advantages are gained by attaching a balloon to a kite in the manner indicated in the accompanying diagram.

In this diagram the captive kite-balloon is shown, the letters of reference being as follows: a^1, octagonal kite,



THE CAPTIVE KITE-BALLOON.

with frame of four pieces of bamboo; b^1, spherical balloon; f, covering of kite (preferably silk); p, extra or top hood; $f^1 f^2$, etc., bands connecting kite and hood with top of balloon; g, ring connecting lower end of kite with the converging net cords of balloon; h, tail of cones (i); l^1, earth-line connected with kite, one branch passing through a pulley to the car (k).

The advantages claimed are: The addition of the kite, with the fastening at the side instead of the base, counteracts the depression produced by the wind, and not only raises its own weight, but even in a light anti-cyclonic breeze elevates the whole apparatus to a higher level than that which could be attained by the balloon alone.

Thus, in an experiment here on Friday, June 10, in the presence of Mr. Eric S. Bruce and others, with a very light wind (I have since ascertained that during the trial the mean velocity at Greenwich, 211 ft. above the sea, with a good exposure for the wind, then northeast, was 12 miles per hour; the present locality was in a valley 260 ft. above sea-level, surrounded by hills, rising 500 ft. above the sea), the balloon, of 113 cub. ft. capacity and with 1,200 ft. of wire out, attained *alone* a mean vertical height of 693 ft., while when attached to a kite of 9 ft. by 7 ft. and the same lengths of wire it kept steadily at 789 ft. The lifting power in the second case was also greatly increased, as shown by the following comparison of the angles of the kite and wire in the two cases:

	Angle of	
	Balloon.	Wire near the ground.
Balloon alone	38°	18°
Balloon with kite	41½°	35°

The lifting power of the balloon with hydrogen was about 5 lbs., the wire weighed about 4 lbs. and the kite 2¼ lbs. The addition of the kite raised 1¼ lbs. more than the balloon could have done alone, with a good deal to spare. It increased the height by 96 ft. and diminished the sag by 13½°.

With the tail (made of self-regulating cones) it completely counteracts the jerky, rotatory, and oscillatory movements of the balloon, by keeping the wire taut and exerting a constant pull on the balloon at its lower extremity.

With the addition of the *top hood*, an essential feature of the combination, the kite shields the balloon fabric from the destructive action of the wind.

The combination can be flown on a much larger percentage of days than the balloon alone.

In a large balloon with car attached the occupant can alter his altitude and azimuth by pulling the lower or side attachment of the kite, and thus extend his area of observation.

With the kite, and except in the rare case of a dead calm, a much smaller balloon is needed to raise a given weight.

The kite portion is portable and easily detachable in the event of a calm.

The use of wire (a suggestion which I owe to Sir William Thomson) greatly increases the strength and lessens the weight of the earth-line.

I arrived at the idea of uniting the two apparatuses while conducting my kite anemometrical observations in 1884, owing to my desire to prevent my kites from coming down suddenly when the wind dropped. I found the balloonists equally desirous of some means for shielding their balloohs from damage and keeping them *up* in a *wind*. The kite-balloon satisfies both requirements, and will, I trust, be of use both to scientific as well as military observation.

Fighting Ships.

A CORRESPONDENT of the London *Times* concisely sums up the arguments of the two parties in the controversy in the question of the proper uses and distribution of armor in fighting ships:

One party, including Sir E. Reed and the majority of naval officers, say that the first duty of a ship is to float, therefore side armor should be used to protect the buoyancy and stability of ships intended to take their place in line of battle, otherwise they will certainly be sunk or capsized by the gun fire of their enemies.

The other party, which includes Sir N. Barnaby, Mr. W. H. White and Sir W. Armstrong, say that their opponents overrate the probability of a ship being sunk by gun fire. It was a very rare occurrence even in the old naval wars, when gun fire was the only mode of attack, but now you have, in addition to gun fire, the ram and the locomotive torpedo, both of which will probably play a very important part in future naval battles; side armor renders no protection against either ram or torpedo, and, in order to be effective against modern artillery, it must be of very great thickness; but if constructors insist on carrying side armor of great thickness all round a ship in order to protect her against the one element of artillery fire, it must be remembered that it renders her more liable to destruction by the other two weapons, ram and torpedo, for it is necessary to curtail her speed and handiness, or else give her a feebler armament or less coal-carrying power, and these last four qualities—viz.: speed, handiness, armament and coal endurance—are of vital importance in a modern man-of-war.

The correspondent, who is a captain in the Royal Navy, says that, in his opinion, the power, or rather the probability, of the ram and torpedo, has been overrated, and the power and probability of the recently developed (and still developing) quick-firing gun have been underrated.

The best of ships for fighting purposes must only be compromises; that if you want more speed you must give up some armor protection, or some armament, or some coal; these are the four great qualities which govern the problem, and you may sit down and ring the changes upon how much of each of these you can get into a ship of a given tonnage at a given cost, remembering that,

while your ship is still building, there will in all probability be some inventions and improvements in engines, guns, torpedoes, compound armor, or something else connected with your art, which, if you do not adopt in your ship, will lay her open to be called obsolete before she is ever put in commission, and lay you open to censure by naval officers and professional rivals; and if you do adopt them, you will alter your ship from her original design, making her, perhaps, too deep in the water, and laying yourself open to the censure of professional rivals and party politicians.

The New Yacht "Volunteer."

(From the *Marine Journal.*)

THE new steel sloop yacht *Volunteer* has surprised the yachting fraternity of the United States by beating her rival sisters *Puritan* and *Mayflower* three out of four races, as follows: From New London to Newport, *Volunteer* beat *Puritan* 7 minutes 21 seconds and the *Mayflower* 56 minutes 43 seconds. In the race for the Goelet cup, from Newport to the entrance to Vineyard Sound, *Volunteer* beat *Mayflower* 8 minutes 42 seconds, *Puritan* 10 minutes 53 seconds. In the race from Vineyard Haven to Marblehead, *Volunteer* beat *Mayflower* 2 hours 23 minutes 29 seconds, while the *Puritan* carried away her topmast and was, of course, out of the race.

The *Volunteer's* rough handling of the *Mayflower* in each of these races is sufficient guarantee that she is a faster boat, and if all signs do not fail she will doubtless be chosen to defend America's cup against the *Thistle*.

The contract for the *Volunteer* was signed between General Paine and Pusey & Jones, of Wilmington, Del., April 5. Only 86 days were required to construct the hull. She was launched July 1, and a few days later towed to Boston to receive her spars and fit out at the yard of Geo. Lawley & Son, South Boston.

Below is given a table of elements of the *Volunteer*, as well as those of other famous sloops, now so well known on both sides of the Atlantic:

PARTS OF THE VESSEL.	*Volunteer.*	*Mayflower.*	*Thistle.*	*Galatea.*	*Priscilla.*	*Atlantic.*	*Puritan.*	*Genesta.*
Length over all......	107	100	106.10	100.6	95	95.1	93	96.5
Length on waterline..	85.10	85	85	86.10	83.3	83.4	81.1	81.6
Beam..................	23	23.6½	20.3	15	22.8	23.10	22.6	15
Beam at waterline....	22	22.3	20	15	22.2	23.2	21.6	15
Depth of hold........	10	10	14.2	13.3	9.4	10.6	9.6	11.9
Draft................	10	10	13.8	13.6	9	9.10	9.3	13
Area midship section.	96	92	115	125	92	102	88	115
Mid section from bow	0.60	0.60	......	......	0.60	0.64	0.58	......
Mast, deck to hounds.	65	63	62	53	61.9	63	60	52
Topmast..............	48	46	45	47	48	48	44	44.6
Boom.................	84	80	80	73	80	78	76	70
Gaff	52	50	50	45	48	48	47	46
Bowsprit outboard...	37	38	38.6	36.6	39.7	38	38	36.6
Spinaker boom.......	70	67	70	65.6	66	70	65	64
Displacement...... ..	116	110	135	157.6	115	120	102.5	140
Inside ballast........	10	14	10	6	47	15	12	5
Keel ballast..........	50	37	55	72	......	47	32	68
Sail area by N. Y. Y. C. rule...	9,000	8,634	8,880	7,505	8,500	8,100	7,370	7,150

The *Volunteer*, though essentially like the *Mayflower* in body, can be viewed as one step nearer the keel vessel. Built of steel, the garboards have been dropped, and the rocker to the gutter keel-plate has been held along well amidships, so that she will draw 18 in. more than the *Mayflower* along the middle where the ballast will be run into the keel. This will bring about a lower center of weight and also more draft than in the *Mayflower*. In racing trim, the *Volunteer* will draw about 10 ft. 9 in., which is only 2 ft. less draft of water than a regular cutter would require, and probably within 2 ft. 6 in. the same as that of the *Thistle*.

She has the same beam at waterline as the *Mayflower*, though she is about one foot longer. The topsides have, however, less flare, so that the *Volunteer* is not so wide across deck. A minor peculiarity of the *Volunteer* is her clipper stem and the accompanying moderate flare in the harpins, in which respect she is similar to the Scotch *Thistle*. The overhang of the *Volunteer* was intended to be of the fashionable cutter style, but the builders introduced a slight variation, which gives to the extreme after end of the overhang an individual character not found in any other yacht. In rig she will be almost a counterpart of the *Thistle*.

The sail area of the *Volunteer* is larger than that of the *Mayflower*, as will be seen by the foregoing table. The foresail is 5 ft. 9 in. longer on the foot, owing to the overhanging stem. The mainsail is 2 ft. longer on foot. Topsail is larger and spinaker boom 3 ft. longer.

The hull of the *Volunteer* has all the strength combined with lightness of material that the best of steel can produce.

The keel is a gutter plate ¾ in. thick; aft it dovetails into the sternpost, and 10 ft. forward of the centerboard trunk it scarfes to the heel of the forward bar keel turned up into the stem. This piece is 6 × 1¼ in. planed almost to a knife-edge from the forefoot up. Sternpost is 2½ in. thick with the rudder tapered away to ½ in. across its after edge. The frame is of angle steel with reverse angles, spaced 2 ft. Diagonal and bilge stringers and deep brackets stiffen the frame, while fore-and-aft strength is supplied by the forged bed piece and casing of the centerboard trunk in connection with keelsons, deck stringers and ties. Deck plank of white pine, 2½ × 3 in. Barring accidents, it is safe to assert that the *America's* cup will remain this side the Atlantic as long as our marine architects can do as well as the designer and builders of the *Volunteer*.

High Pressure and Forced Draft for Marine Engines.

(From the London *Engineering*.)

SOME important trials of the new machinery of the screw steamer *Ohio*, belonging to the International Navigation Company, have recently taken place on the Clyde. The *Ohio* is an American built steamer measuring 343 ft. × 43 ft. × 34 ft. 6 in., and of 3,325 tons gross. She has been entirely refitted with new engines and boilers by Messrs. James Howden & Co., Glasgow, who also rearranged the bunker, machinery and hold-spaces, so as to give the important advantage of increased cargo accommodation obtainable from the use of their improved machinery, which occupies considerably less space than the engines and boilers of the same power which have been replaced. The new engines are of the triple-expansion type, and the boilers, which are designed for supplying steam of 150 lbs. pressure, are worked on Howden's system of forced draft, which combines increased power with high economy in fuel. The object of the owners in refitting the *Ohio* was to test the capability and economy of this system of forced draft on a sufficient scale to guide them in dealing with steamships of the largest class and great power.

In the refit of the *Ohio* the boilers were designed to work with a very moderate air-pressure, this being sufficient for the power required by the contract. The combined power and economy, however, guaranteed by Messrs. Howden & Co. for the use of their system of forced draft was higher than has hitherto been attempted in any steamship, and sufficient, if attained, to prove the large reduction that could safely be made in the number and size of boilers for the use of the system, and the quantity of coal required to produce a given power. The contract for the refit of the steamer required that 2,100 indicated H. P. (which was the maximum power of the engines removed) should be maintained during the trial on a consumption of 1.25 lbs. of coal per I. H. P. per hour. Originally, the boilers of the *Ohio*, from which this power was produced, were three in number, double-ended, 12 ft. 6 in. in diameter by 17 ft. 6 in. in length, having each 6 furnaces 3 ft. in diameter, or 18 furnaces in all, with an aggregate fire-grate area of 300 sq. ft. The new boilers, fitted with the forced draft, are likewise three in number, but single-ended, 13 ft. in diameter by

11 ft. 2 in. in length, having each 3 furnaces 3 ft. 3 in. in diameter, or 9 furnaces in all, with an aggregate fire-grate area of 112 sq. ft. Air for combustion is supplied to the boilers by one of Messrs. W. H. Allen & Co.'s fans, 5 ft. 6 in. in diameter, driven direct by an engine having a cylinder 7 in. in diameter with stroke of 4 in. The boilers removed had two stokeholds across the ship, one fore and one aft of the boilers, while the new boilers have only one stokehold on the after side. The engines removed have cylinders 57 in. and 90 in. in diameter, by 48 in. stroke, while the new engines have three cylinders 31 in., 46 in. and 72 in. in diameter, respectively, with piston stroke of 51 in.

During the trials the coals were weighed out under the supervision of the officers of the company, who also took the record of speed and other data. After running down Channel for a considerable time, the trial on the coals weighed out began and lasted 4 hours 10 minutes, during which time 10,885 lbs. of Welsh coal were burned, the trial ending with the same revolutions of engines and the same pressure in boilers with which it began. The mean I. H. P. calculated from the mean of seven sets of indicator cards, taken during the trial, and the mean revolutions per minute, found by dividing the total revolutions recorded on the engine counter by the minutes in the period of the trial, amounted to 2,124, thus making the consumption 1.23 lbs. per I. H. P. per hour, and the power per square foot of fire-grate almost exactly 19 I. H. P. While testing the I. H. P. and consumption of coal, the steamer ran to and fro between the Cloch and Cumbrae Lights, and also made several runs on the measured mile at Skelmorlie, from which the mean speed of the vessel was found to be 14.12 knots per hour. The remarkably high results obtained were most satisfactory to the representatives of the owners, and a large party of experts on board congratulated Mr. Howden on the successful fulfilment of the onerous guarantees undertaken.

While speaking of the *Ohio*, it may be worth while to give a few particulars regarding experience gained by another ship-owning firm with Howden's triple-expansion engines and forced-draft system. About nine months ago, Robert MacAndrew & Co., of London, had two steamers built on the Tyne which were exact duplicates of each other in respect of hulls, engines and boilers, the engines being of the triple-expansion type, while the boilers had a working pressure of 160 lbs. per sq. in. At sea, the engines gave out about 600 I. H. P. The steamers run in the same trade, which is between Hamburg and Barcelona. In one steamer the boiler was fitted and is worked with Mr. Howden's forced draft, and the other is worked with natural draft. In both cases, however, the boilers were originally designed for working with natural draft. Messrs. MacAndrew & Co. report, regarding the *Churruca*, one of the steamers, that, after she had worked for seven or eight months as at first fitted, she was supplied with the forced-draft appliances, which enabled her to perform the round voyage from Hamburg to Barcelona and back on 207 tons of coal, while her sister ship, the *Gravina*, under the same conditions, required 264 tons of coal for the same run; so that the saving by using the forced draft was nearly 22 per cent. Howden & Co. are just completing two sets of engines of 1,200 I. H. P. each for MacAndrew & Co., the boilers being arranged for working on the forced-draft system.

The Electric Current as a Means of Increasing and Varying the Tractive Adhesion of Railroad Motors and Other Rolling Contracts.

[American Association for the Advancement of Science. New York meeting of 1887. Paper by Elias E. Ries.]

THE object of this paper is to lay before you the results of some recent experiments in a comparatively new field of operation, but one that, judging from the results already attained, is destined to become of great importance and value in its practical application to various branches of industry.

I say "comparatively new," because the underlying principles involved in the experiments referred to have to a certain extent been employed (in, however, a somewhat restricted sense) for purposes analagous to those that form the basis of this communication.

As indicated by the title, the subject that will occupy our attention is the use of the electric current as a means of increasing and varying the frictional adhesion of rolling contacts and other rubbing surfaces, and it is proposed to show how this effect may be produced both by means of the direct action of the current itself, and by its indirect action through the agency of electro-magnetism.

Probably the first instance in which the electric current was directly employed to vary the amount of friction between two rubbing surfaces was exemplified in Edison's electro-motograph, in which the variations in the strength of a telephonic current caused corresponding variations in friction between a revolving cylinder of moistened chalk and the free end of an adjustable contact arm whose opposite extremity was attached to the diaphragm of the receiving telephone. This device was extremely sensitive to the least changes in current strength, and if it were not for the complication introduced by the revolving cylinder it is very likely that it would to-day be in more general use.

It has also been discovered, more recently, that in the operation of electric railroads, in which the track-rails form part of the circuit, a considerable increase in the tractive adhesion of the driving-wheels is manifested, due to the passage of the return current from the wheels into the track. In the Baltimore & Hampden electric railroad, using the Daft "third-rail" system, this increased tractive adhesion enables the motors to ascend without slipping a long grade of 350 ft. to the mile, drawing two heavily loaded cars, which result, it is claimed, is not attainable by steam or other self-propelling motors of similar weight. In the two instances just cited, the conditions are widely different as regards the nature of the current employed, the mechanical properties of the surfaces in contact and the electrical resistance and working conditions of the respective circuits. In both, however, as clearly demonstrated by the experiments hereinafter referred to, the cause of the increased friction is substantially the same.

In order to ascertain the practical value of the electric current as a means of increasing mechanical friction, and, if possible, to render it commercially and practically useful wherever such additional friction might be desirable, as for example in the transmission of power, etc., a series of experiments were entered into by the author, which, though not yet fully completed, are sufficiently advanced to show that an electric current, when properly applied, is capable of very materially increasing the mechanical friction of rotating bodies, in some cases as much as from 50 to 100 per cent., with a very economical expenditure of current; this increase depending upon the nature of the substances in contact and being capable of being raised by an increased flow of current.

Before entering into a description of the means by which this result is produced, and how it is proposed to apply this method practically to railroad and other purposes it may be well to give a general outline of what has so far been determined. These experiments have shown that the co-efficient of friction between two conducting surfaces is very much increased by the passage therethrough of an electric current of low electro-motive force and large volume, and this is especially noticeable between two rolling surfaces in peripheral contact with each other, or between a rolling and a stationary surface, as in the case of a driving-wheel running upon a railroad rail. This effect increases with the number of ampères of current flowing through the circuit of which the two surfaces form part and is not materially affected by the electromotive force so long as the latter is sufficient to overcome the electrical resistance of the circuit. This increase in frictional adhesion is principally noticeable in iron, steel and other metallic bodies and is probably due to a molecular change in the conducting substances at their point of contact (which is also the point of greatest resistance in the circuit), caused by the heat developed at that point. This heat is ordinarily imperceptible and becomes

apparent only when the current's strength is largely augmented. It is, therefore, possible that a portion of this increased tractive adhesion is due directly to the current itself, aside from its heating effect, although I have not as yet been able to ascertain this definitely. The most economical and efficient results have been obtained by the employment of a transformed current of extremely low electro-motive force (between one-half and one volt), but of very large volume or quantity, this latter being variable at will so as to obtain different degrees of frictional resistance in the substances under observation.

These experiments were originally directed mainly toward an endeavor to increase the tractive adhesion of the driving-wheels of locomotives and other vehicles, and to utilize the electric current for this purpose in such a manner as to render it entirely safe, practical and economical. It will be apparent at once that a method of increasing the tractive power of the present steam locomotives by more than 50 per cent. (without adding to their weight and without injury to the roadbed and wheel tires such as caused by the sand now commonly used) would prove of considerable value, and the same holds true with respect to electrically propelled street-cars, especially as it has been found exceedingly difficult to secure sufficient tractive adhesion on street-railroads during the winter season, as well as at other times, on roads having grades of more than ordinary steepness. As this, therefore, is probably the most important use for this application of the electric current it has been selected for illustrating this paper.

I have here a model car and track arranged to show the equipment and operation of the system as applied to railroad motors. The current in the present instance is one of alternating polarity, which is converted by this transformer into one having the required volume. The electro-motive force of this secondary current is somewhat higher than that necessary. In practice it would be about half a volt. You will notice upon a closer inspection that one of the forward driving-wheels is insulated from its axle, and the transformed current, after passing through a regulating switch under the control of the engineer or driver, goes to this insulated wheel, from which it enters the track-rail, then through the rear pair of driving-wheels and axle to the opposite rail and flows up through the forward uninsulated wheel, from the axle of which it returns by way of a contact brush to the opposite terminal of the secondary coil of the transformer. Thus the current is made to flow *seriatim* through all four of the driving-wheels completing its circuit through that portion of the rails lying between the two axles, and generating a sufficient amount of heat at each point of contact to produce the molecular change before referred to. By means of the regulating switch the engineer can control the amount of current flowing at any time, and can even increase its strength to such an extent in wet or slippery weather as to evaporate any moisture that may adhere to the surface of the rails at the point of contact with the wheels, while the locomotive or motor car is under full speed.

It will be apparent that, inasmuch as the traction circuit moves along with the locomotive and is complete through its driving-wheel base, the track rails in front and rear of the same are at all times entirely free from current, and no danger whatever can occur by coming in contact with the rails between successive motors. Moreover, the potential used in the present arrangement, while sufficient to overcome the extremely low resistance of the moving circuit, is too small to cause an appreciable loss of current from that portion of the rails in the circuit, even under the most unfavorable conditions of the weather. In practice the primary current necessary is preferably generated by a small high-speed alternating dynamo on the locomotive, the current being converted by means of an inductional transformer similar in construction to the one here shown. To avoid the necessity for electrically bridging the rail-joints, a modified arrangement may be employed, in which the electrical connection is made directly with a fixed collar on the forward and rear driving-axles, the current dividing itself in parallel between the two rails in such a manner that if a defective joint exist in the rail at one side the circuit is still complete through the rail on the other, and as the rails usually break joints on opposite sides this arrangement is found very effective. The insulation of the driving-wheels is very effective in either case.

As the amount of additional tractive adhesion produced depends on the quantity of current flowing, rather than upon its pressure, the reason for transforming the current, as described, will be apparent, and its advantages over a direct current of higher tension and less quantity, both from an economical and practical standpoint, will, for this reason, be clear. The amount of heat produced at the point of contact between the wheels and rails is never large enough to injure or otherwise affect them, although it may be quite possible to increase the current sufficiently to produce a very considerable heating effect. The amount of current sent through the traction circuit will, of course, vary with the requirements, and, as the extent to which the resistance to slipping may be increased is very great, this method is likely to prove of considerable value. While, in some cases, the use of such a method of increasing the tractive power of locomotives would be confined to ascending gradients and the movement of exceptionally heavy loads, in others it would prove useful as a constant factor in the work of transportation. In cases like that of the New York Elevated Railroad system, for example, where the traffic during certain hours is much beyond the capacity of the trains, and the structure unable to support the weight of heavier engines, a system like that just described would prove of very great benefit, as it would easily enable the present engines to draw two or three additional cars with far less slipping and loss to motion than is the case when mechanical friction and weight alone is relied upon at a cost for tractive current that is insignificant compared to the advantages gained. Other cases may be cited in which this method of increasing friction will probably be found useful, aside from its application to railroad purposes, but these will naturally suggest themselves and need not be further dwelt upon.

In the course of the experiments above described, another and somewhat different method of increasing the traction of railroad motors has been devised, which is more particularly adapted to electric motors for street railroads, and is intended to be used in connection with a system of electric street railroads now being developed by the author. In this system electro-magnetism provides the means whereby the increase in tractive adhesion is produced, and this result is obtained in an entirely novel manner. Several attempts have heretofore been made to utilize magnetism for this purpose, but apparently without success, chiefly because of the crude and imperfect manner in which most of these attempts have been carried out. The present system owes its efficiency to the formation of a complete and constant closed magnetic circuit, moving with the vehicle and completed through the two driving-axles, wheels and that portion of the track-rails lying between the two pairs of wheels, in a manner similar to that employed in the electrical method before shown. We have here a model of a second motor-car equipped with the apparatus mounted on a section of track and provided with means for measuring the amount of tractive force exerted both with and without the passage of the current.

You will notice that each axle of the motor-car is wound with a helix of insulated wire, the helices in the present instance being divided to permit the attachment to the axles of the motor connections. The helices on both axles are so connected that when energized they induce magnetic lines of force that flow in the same direction through the magnetic circuit. There are, therefore, four points at which the circuit is maintained closed by the rolling wheels, and as the resistance to the lines of force is greatest at these points, the magnetic saturation there is most intense and produces the most effective results just where it is most required. Now, when the battery circuit is closed through the helices, it will be observed that the torque or pull exerted by the motor-car is fully twice that exerted by the motor with the traction circuit open, and by increasing the battery current until the saturation

point of the iron is reached the tractive force is increased as shown by the dynamometer. A large portion of this resistance to the slipping or skidding of the driving-wheels is undoubtedly due to direct magnetic attraction between the wheels and track, this attraction depending upon the degree of magnetic saturation and the relative mass or metal involved, but by far the greater proportion of the increased friction is purely the result of the change in position of the iron molecules due to the well-known action of magnetism, which causes a direct and close interlocking action, so to speak, between the molecules of the two surfaces in contact. This may be illustrated by drawing a very thin knife-blade over the poles of an ordinary electro-magnet, first with the current on and then off.

In the model before you the helices are fixed firmly to and revolve with the axles, the connections being maintained by brushes bearing upon contact rings at each end of the helices. If desired, however, the axles may revolve loosely within the helices, and instead of the latter being connected for cumulative effects, as illustrated, they may be arranged in other ways so as to produce either consequent or opposing magnetic forces, leaving certain portions of the circuit neutral and concentrating the lines of force wherever they may be most desirable. Such a disposition will prove an advantage in some cases.

The amount of current required to obtain this increased adhesion in practice is extremely small, and may be entirely neglected when compared to the great benefit derived. The system is very simple and inexpensive, and the amount of traction secured is entirely within the control of the motor-man as in the electric system. It will be seen that the car here will not, with the traction circuit open, propel itself up hill when one end of the track is raised more than 5 in. above the table, but with the circuit energized, will readily ascend the track as you now see it, with one end about 13 in. above the other in a length of 3 ft., or the equivalent of a 40 per cent. grade, and this could be increased still further if the motor had power enough to propel itself against the force of gravity on a steeper incline, as you will notice the motor adheres very firmly to the track and requires a considerable pull to force it down this grade, whereas with the traction circuit open, it slips down in very short order, notwithstanding the efforts of the driving mechanism to force it up.

The resistance of the helices on this model is less than two ohms, and this will scarcely be exceeded when applied to a full-sized car, the current from two or three cells of secondary battery being probably sufficient to energize them.

The revolutions of the driving-axles are not interfered with in the slightest, the former, because the axle-boxes are outside the path of the lines of force, and the latter, because each wheel practically forms a single pole-piece, and in revolving presents a continuously new point of contact of the same polarity to the rail, the flow of the lines of force being most intense through the lower half of the wheels, and on a perpendicular line connecting the center of the axle with the rail. In winter all that is necessary is to provide the motor-car with a suitable brush for clearing the rails sufficiently to enable the wheels to make good contact therewith, and any tendency to slipping or skidding may be effectually checked. By this means it is easily possible to increase the tractive adhesion of an ordinary railroad motor from 50 to 100 per cent. without any increase in the load or weight upon the track, for it must be remembered that even that portion of the increased friction due to direct attraction does not increase the weight upon the road-bed, as this attraction is mutual between the wheels and the track-rails; and if this car and track were placed upon a scale and the circuit closed, it would not weigh a single ounce more than with the circuit open.

It is obvious that this increase in friction between two moving surfaces can also be applied to check as well as augment the tractive power of a car or train of cars, and I have shown, in connection with this model, a system of braking that is intended to be used in conjunction with the electro-magnetic traction system just described. You will have noticed that in the experiments with the traction circuit the brake-shoes here have remained idle, that is to say, they have not been attracted to the magnetized wheels. This is because a portion of the traction current has been circulating around this coil on the iron brake-beam, inducing in the brake-shoes magnetism of like polarity to that in the wheels to which they apply. They have, therefore, been repelled from the wheel-tires instead of being attracted to them. Suppose now that it is desired to stop the motor-car; instead of applying the traction circuit, the current flowing through the helices is simply reversed by means of the pole-changing switch, whereupon the axles are magnetized in the opposite direction, and the brake-shoes are instantly drawn to the wheels with a very great pressure, as the currents in the helices and the brake-coil now assist each other in setting up a very strong magnetic flow, sufficient to bring the motor-car almost to an instant stop, if desired.

The same tractive force as has previously been applied to increase the track adhesion now exercises its influence upon the brake-shoes and wheels, with the result of not only causing a very powerful pressure between the two surfaces, due to the attractive force, but also offering an extremely large frictional resistance, by virtue of the molecular interlocking action before referred to—part traction and part braking.

The method just described is equally applicable to increase the co-efficient of friction in apparatus for the transmission of power, its chief advantage for this purpose being the ease and facility with which the amount of friction of two wheels can be varied to suit different requirements, or increased or diminished (either automatically or manually), according to the nature of the work being done. With soft iron contact surfaces, the variation in friction is very rapid and sensitive to slight changes in current strength, and this fact may prove of value in connection with its application to regulating and measuring apparatus. In all cases the point to be observed is to maintain a closed magnetic circuit of low resistance through the two or more surfaces, the friction of which it is desired to increase, and the same rule holds good with respect to the electric system, except that in the latter case the best effects are obtained when the area of surface in contact is smallest. For large contact areas the magnetic system is found to be most economical, and this system might possibly be used to advantage to prevent slipping of short wire ropes and belts upon their driving-pulleys (in cases where longer belts are inapplicable), such as in the driving of dynamos and other machinery.

Experiments have also been and are still being made with the object of increasing friction by means of permanent magnetism, and also with a view to *diminishing* the friction of revolving and other moving surfaces, the results of which will probably form the subject matter of a subsequent paper.

Enough has been said to indicate that the development of these two methods of increasing mechanical friction opens up a new and extensive field of operation, and enables electricity to score another important point in the present age of progress. The great range and flexibility of this method peculiarly adapt it to the purposes we have considered, and to numerous others that will, doubtless, suggest themselves to you. Its application to the increase of the tractive adhesion of railroad motors is probably its most prominent and valuable feature at present, and is calculated to act as an important stimulus to the practical introduction of electric railroads in our city streets, inasmuch as the claims heretofore made for cable traction in this respect are now no longer exclusively its own. On trunk-line railroads the use of sand and other objectionable traction-increasing appliances will be entirely dispensed with, and locomotives will be enabled to run at greater speeds with less slipping of the wheels and less danger of derailment. Their tractive power can be nearly doubled without any increase in weight, enabling them to draw heavier trains and surmount steeper grades without imposing additional weight or strain on bridges and other parts of the road-bed. Inertia of heavy trains can be more readily overcome,

loss of time due to slippery tracks obviated, and the momentum of a train at full speed almost instantly checked by one and the same means.

The Future of Electrical Transportation.

(From the *Electrician and Electrical Engineer.*)

THE application of electricity as a motive power for railroad trains, the earliest conception of which appears to be due to that eccentric genius, Henry Pinkus, "late of Pennsylvania, in the United States of America, gentleman," who flourished in London *circa* 1840, has apparently passed through its preliminary experimental period, as exemplified by the work of Siemens at Berlin, Edison at Menlo Park, Finney at Pittsburgh, and Field at Chicago, and has now reached the stage of a somewhat extended practical development. This era in the progress of the art may be said to have commenced with the Lichterfelde line of Siemens, opened May 16, 1881, which was followed by the Portrush line, September 30, 1882, and these two by many others, as given in Mr. Martin's table recently published. At the present moment a glance at the technical journals is sufficient to show that electric railroad enterprises are springing up like mushrooms in every direction, both in this country and abroad.

It may not be uninteresting at the present juncture to attempt to forecast some of the probabilities of the future development of electric transportation, in the light of what has already been accomplished.

In one field, that of surface street railroads, the universal employment of the electric motor is without doubt only a question of time, and not a very long time either. The practical success which has everywhere attended the introduction even of the comparatively crude methods and apparatus at present in use are a sufficient evidence of the ultimate fulfilment of the prophecy. Even the ingenious and efficient, though expensive, cable system is certainly destined to follow the patient plodding horse into the limbo of superseded and obsolete street-car motors.

The next field to be occupied is that of the elevated and other city and suburban rapid transit passenger lines. This undertaking is a far more difficult one, but its accomplishment may, in our opinion, be looked for at no distant day. The conditions of the problem have been thoroughly mastered, the obstacles to be met with are sufficiently well appreciated and understood, and meanwhile several of the ablest practical electricians of the day are devoting their best energies to the subject. No less than 4 electric locomotives designed for this class of service are under construction by different parties at the present time, and we shall be much disappointed if one or more of them does not, upon trial, give sufficiently favorable results to render the future success of electric traction on railways of this class an assured success. The relief to the public in being freed from the annoyance of steam, smoke and cinders, and in great measure of noise as well, will be incalculable, while the probable resulting economy in operating expenses, although in our opinion considerably overestimated by sanguine inventors, will, nevertheless, be sufficient to render the change a profitable one to the owners of the roads.

Another field, and one in which the electro-locomotive of the future may be expected to achieve its greatest triumphs, is that of rapid passenger traffic between our chief commercial centers. Steam locomotion, so far as speed is concerned, has practically reached its limit. The unavoidable restrictions of bulk and weight forbid any material increase in the power of the express locomotive of to-day. No such restrictions apply to the electric engine. The amount of power which by this means it is possible to apply to the axles of an ordinary train without materially increasing its weight, may, without exaggeration, be said to be almost limitless. We believe that the rapid transit railroad of the future will have its trains propelled by electricity; it will be straight, as the crow flies; it will follow the topographical undulations of the country almost regardless of grades, and its trains will attain a speed of more than 100 miles per hour with safety. Without doubt, this may be looked forward to as the next great step in the progressive improvement of the art of transportation.

It remains to speak of another development of electric transport, which for some occult reason has failed, at least in this country, to attract the attention that its importance deserves—the telpher system.

This ingenious invention, although apparently perfectly successful at Glynde, England, where it has been for quite a long time in practical operation, can be expected to have but a limited field of usefulness in the land of its nativity, compared with that which awaits it in the rugged and mountainous regions of our western mining States, to say nothing of the vast undeveloped territories of Mexico and Central and South America.

We have thus briefly indicated some of the probable future lines of development of electric transportation. Doubtless many others will discover themselves from time to time, as the ceaseless march of improvement goes on; but what the ultimate outcome will be is scarcely less difficult of prediction at the present moment than it was in the days of "Henry Pinkus, of Pennsylvania," now almost half a century ago.

Coal Production in Russia.

(Report of A. J. Fay, U. S. Consul at Stettin, to the State Department.)

IN Russia a further rise in the duty on iron is impending, and the owners of the Donetz coal mines have also the prospect that further taxes will be imposed on foreign coal.

The output of Russian coal in 1860 amounted to 10,000,000 poods (about 164,000 tons), whereas it increased in 1885 to 262,000,000 poods (about 4,360,000 tons), of which the Donetz District mined about 2,000,000 tons, the Perm District about 250,000, Poland 1,300,000, Moscow 500,000, and the Killo District the balance.

Notwithstanding this enormous increase, the production of coal in Russia only amounts to 0.3 per cent. of the total output of the seven leading countries of the world.

The production of coal being so small in Russia, one would think that it would be a staple article, and that the mines in the Caucasus, the Ural, Siberia, Turkestan, etc., could be advantageously worked; but such is not the case, as the output of the Donetz Basin of 2,000,000 tons, which consists of nearly 40 per cent. of anthracite, partly remains unsold. In the years 1883 and 1884, nearly 15 per cent. of the output remained unsold; nevertheless several million fathoms of wood are annually burned.

In order to stop the importation of English coal a duty of 2 copecks per pood (about 70 cents per ton) in gold was petitioned for and granted for the ports of the Black Sea, and ½ copeck per pood for the ports of the Baltic; but this had not the desired effect. The English coal could not be displaced, and a higher duty was necessary. Three copecks were granted for the Black Sea ports; but even this duty does not displace the English coal from these ports. Now it is proposed to further raise the duty to 3½ copecks from the Black Sea ports and 2 copecks for the ports of the Baltic. Probably this higher duty will not have the desired effect, because, according to the Riga and Odessa Exchange Committee and the Moscow Technical Society, the Donetz coal is inferior to the English and German; moreover, the cost of producing or mining the coal is greater than is the case in the last-named countries. Russia is still very backward with its technical contrivances in mining.

Mr. Radzig is of the opinion that a further advance in the duty on coal for the ports of the Black Sea would be detrimental to agriculture in the South. Respecting a higher duty for the Baltic ports, the consumption of coal at Moscow would decrease rapidly.

At the present prices of 22 to 23 copecks per pood the consumption of coal at Moscow does not exceed 10,000,000 poods, as many manufacturing industries burn wood, and a higher duty would compel all other industries to use the same fuel, while the Donetz coal owners would certainly not profit by it Moscow, with the surrounding country, consumes annually about 1,000,000 fathoms of

wood, equal to 100,000,000 poods of coal, and the Donetz District could not only supply the manufacturers, but also the owners of houses as well, if coal could be had at reasonable prices, but high prices would induce none to make a change.

English coal, which is far superior to the Donetz coal, is difficult to place at 22 to 23 copecks, whereas Donetz coal at these prices would find no purchaser if an increased duty should be granted.

In order to augment the sales of the Donetz coal the construction of a railroad is contemplated, which will be about 60 German miles in length, the estimated cost of which is 22 000,000 rubles. Mr. Radzig is of the opinion that this road will have neither freight nor passengers to transport, and that the sale of the Donetz coal can only be augmented by the projected canal which is to connect the Azov with the Black Sea. He writes that this canal will be built by a French corporation, with a capital of 25,000,000 rubles. The Azov is very stormy, and is only navigable about 60 days in the year, this being the reason that the cost of transportation of coal from Marinpol to Odessa or Nicolajau is high, namely, 5 to 8 copecks per pood.

The transporting of coal from Marinpol by canal would probably not exceed 3 to 4 copecks per pood, which would enable the Donetz coal to compete with the English coal.

Mr. Radzig writes that the Donetz coal, because of its bad quality, will never be able to compete with the English article at the Baltic ports, and that only by reducing the railroad freights will it be possible to open up larger markets for it.

Russia has two large manufacturing centers, namely, Poland and Moscow, with surrounding districts. The former has good coal in the vicinity, which is mined mostly by Germans. The latter uses wood, or the dearer and worse Donetz coal. The English coal cannot be obtained, because of the high railroad rates and the increased duty.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Continued from page 362.*)

WE continue below the condensed summary of the reports of the Board of Trade Inspectors on accidents on British railroads, resulting from breakages of wheels and tires. This summary was begun in the June number of the JOURNAL, and in that number its method and purposes were explained.

In the last number the reports closed with the year 1875; the present summary covers the years 1876–1881, inclusive.

ACCIDENT REPORTS.

February 7, 1876, passenger train on London & Southwestern road was derailed near Micheldever, by the breaking of a tire under a brake-van. Three cars left the rails, and a passenger was hurt. The tire broke into six pieces, five of which were scattered along the line, while the remaining one could not be found. The tire was of Bessemer steel and was put in use in June, 1873; it had been turned down in October, 1874. It was 1½ in. thick on tread at the time of the accident. It was fastened to the wheel on the Beattie system, having a slanting dovetail on the outer side and 8 clips on the inside. In the case of four of the parts of the tire hammered down over the clips, the portions hammered down had been broken away, while a fifth was cracked nearly through. One of the breaks showed an old flaw extending over about one-third of the section. In this case the wheel-center also broke, one-half the rim and three spokes having been broken off. The Inspector, while admitting that this system of fastening was a decided advance on the old method of using rivets, says: "The weakness of this system of fastening, which I have previously had occasion to point out, was conspicuous in this instance of failure. The slanting dovetail at the edge did not possess the security afforded by a squared shoulder; and the hammered-down portions of the lip were not strong enough to resist the strain exerted by the tire, as, in flying open on fracture, it escaped from the slanting surfaces. It is only another proof that, as I have often pointed out, the best principles which can be adopted in tire-fastenings are those of squared shoulders and continuous clips on both sides of the tire."

June 5, 1876, a passenger train on the Great Eastern Railway was derailed near Edmonton Junction by the breaking of a tire under the brake-van. No car left the rails except the van. A guard was hurt. The tire was cast-steel, had been in use three years and had been twice turned off. It was originally 2⅛ in. thick on the tread, and had, by wear and turning, been reduced to 1⅛ in. It was secured to the wheel by a lip on the outside and 5 screw-bolts, ⅞ in. in diameter, screwed from the rim of the wheel to a depth of ¾ in. into the tire. This was an old fastening, the company having since adopted the Mansell fastening for its tires. The Inspector says: "The system of tire-fastening used on this wheel has two principal defects: 1, The absence of a continuous clip on the outside of the wheel. 2, The want of a square shoulder on the clip applied to the inside of the wheel. It is the more necessary to draw attention to these defects, because the locomotive and carriage superintendents of some railroads are still in the habit of adopting a similar system of fastening for the wheels of engines, as well as in some cases for the wheels of vehicles used in passenger trains."

December 17, 1878, a brake-van in a passenger train on the Midland Great Western (Ireland), was derailed near Blanchardstown by a broken tire. This tire was of crucible steel, was two years old and had been worn down from 2 in. to 1¾ in. thick on tread. It was 42 in. diameter and was fastened to the wheel-center by 4 bolts. It broke into four pieces, all of which left the wheel. No cause is assigned for the breakage other than "the brittle state of the metal and hard condition of permanent way induced by the severe frost."

December 20, 1878, locomotive of passenger train on Midland Great Western (Ireland), was derailed near Donamore by the breaking of the tire on a driving-wheel. The tire broke in one place only; it did not leave the wheel but opened out about ⅝ in. at the break. The tire was of crucible steel, had been in use 7 years and had run 115,043 miles. It was 6 ft. 6 in. diameter, and had been worn and turned down from 2½ in. to 1⅞ in. thick on the tread. It was fastened to the wheel-center by bolts or set-screws passing through the rim and into the tire. It broke transversely through a bolt-hole, and no flaw being apparent at the break. A damaged rail was found in the track, and it was most probable, the Inspector thought, that the breakage of the tire was caused by striking this damaged rail. The weight on the single pair of drivers was 14¾ tons.

September 24, 1880, a carriage in a train on the London, Brighton & South Coast road was derailed near Ford Junction by the breaking of a wheel. This was a Mansell wheel with wooden center, and the woodwork broke away entirely from the hub. The Inspector says: "The central portion connecting the tire of the wheel with the boss was entirely of teak-wood, 3½ in. thick, the tire being fastened to the wood by two circular plates or rings of wrought-iron, 3 in. wide by $\frac{7}{16}$ in. thick, one on each side, by 16 bolts ⅝ in. diameter. The central part of the wood is secured to a circular cast-iron plate, 20 in. diameter and 1⅛ in. thick, forming part of the inside of the boss of the wheel, by 8 bolts ⅞ in. diameter, passing through this cast-iron plate, through the ring and through a circular plate or ring of wrought-iron 5½ in. wide and ¾ in. thick on the opposite or outside of the boss of the wheel, the nuts being on the inner side." In this case the wood seemed to be good and sound, but was torn entirely away from the hub. The cast-iron plate was broken into 9 pieces, but the bolts were not broken. It was thought that the holes in the wood had worn and grown loose, and that the final break was due to the torsion produced by application of the brakes.

The Inspectors' general report for the year 1880, says: "Of the 1,238 tires which failed, 50 were engine tires, 50 tender tires, 13 carriage tires, 40 van tires and 1,085 wagon tires. Of these tires 993 were of iron and 231 of steel, while in 14 cases the material was not stated. There were 50 fastened to the wheel by Gibson's method, one of which left the wheel when it broke; 24 by Beattie's method, 16 by Mansell's, 40 by Drummond's and one by Brotherhood's, all of which remained on the wheels when they failed; 1,090 were fastened to the wheel-centers by bolts or rivets, of which 10 left the wheels when broken; 17 were secured by other methods, none of them leaving the wheels. There were 96 tires broken at rivet-holes, 215 in the solid, 13 at the weld and 914 split longitudinally or bulged.

In 1881, again, no wheel or tire accidents were especially reported on. The Inspectors' general report says: "Of the 1,286 tires which failed, 66 were engine tires, 46 tender tires, 8 carriage tires, 55 brake-van tires and 1,111 wagon tires. Of the tires 993 were of iron, 293 of steel; 46 of the tires were fastened to the wheel-centers by Gibson's patent method, 21 by Beattie's patent, 16 by Mansell's patent, 45 by Drummond's patent, all of which remained on their wheels when they failed. There were 1,134 tires fastened to the wheels by bolts or rivets, and 8 of these left their wheels when they failed. In addition, 24 tires were fastened by various other methods and none of these left the wheels on failure. There were 138 tires broken at rivet-holes, 307 in the solid, 7 at the weld and 834 split longitudinally or bulged.

In the year 1876, there were 880 breakages of tires and 74 of wheels reported. In these 954 accidents, only two persons were injured and, as seen above, only two of the accidents were serious enough to require investigation.

In the year 1877, the total number of accidents reported by the railroads of the United Kingdom, as resulting from breakage of tires, was 918; from breakage of wheels, 37; a total of 995 accidents. That these accidents were slight in their nature is shown by the fact that in the whole number not a single person was reported as killed or injured. In fact they were generally of so small importance that none of them required special investigation, and no reports on accidents of this class were made by the Inspectors. Apparently those officers had become tired of repeating their advice on the subject of better fastenings for tires, or else that advice had been taken, with the result of making tire-breakages comparatively harmless, although it had not been possible to prevent them altogether.

In the year 1878, there were reported no less than 1,034 accidents from broken tires and 20 from broken wheels; a total of 1,054 accidents. In all of these accidents there was only one person injured, a railroad employé. As in 1877, while the number of these accidents was large, they were evidently slight in their nature. At any rate only two special reports were thought necessary; both of these accidents were on the same road.

In 1879, there were 1,227 broken tires and 19 broken wheels reported; in all these accidents only 2 employés were injured, and no accidents were specially reported on.

In 1880, there were 1,238 broken tires and 7 broken wheels, and only one accident was reported on, a broken wooden wheel.

In 1881, while 1,286 broken tires and 3 broken wheels were recorded, there were no special reports made by the Inspectors.

From 1875 to 1881, inclusive, the number of breakages of wheels and tires reported by the railroad companies, with the total train mileage for each year, was as follows

	Breakages.			
	Wheels	Tires.	Total.	Train-mileage.
1875	660	112	772	209,528,186
1876	880	74	954	215,711,739
1877	918	37	955	219,895,751
1878	1,034	20	1,054	221,376,114
1879	1,227	19	1,246	225,851,842
1880	1,238	7	1,245	240,956,494
1881	1,286	3	1,289	259,629,442

The comparison with train mileage is necessarily a very unsatisfactory one, when as the varying length of trains of different description is considered. It must also be remembered that during the years covered by the table, there was a gradual increase in the size of locomotives, so that a train-mile in 1881 probably represented a greater mileage of vehicles than in 1875. A much more satisfactory way would be to follow the method in use in German railroads, where reports are made, not by train-miles nor even by car-miles, but by *axle-miles.* This plan of following the axle-mileage would be of comparatively little importance in this country, where all but comparatively a very few cars have light wheels; but in England and other European countries, where cars have four, six or eight wheels, it is necessary to go further than car-mileage, if accurate statistics are wanted.

(*To be continued.*)

Manufactures.

The Lake Champlain Iron Region.

THE Lake Champlain iron and ore interests took a decided advance during the past spring, and the present summer as yet shows no decline in the boom. The two furnaces at Port Henry, N. Y., formerly owned by the Bay State Iron Company, were purchased last November by Witherbees, Sherman & Foote and one of the furnaces put in blast in February after being idle for three years. The other has been undergoing repairs and is now about ready to start.

The Cheever Ore-bed property lately purchased by Tuckerman & Presbury is again being worked, half of the ore used at the Bay State Furnace coming from that mine. The ore is a rich magnetite carrying about 0.30 phosphorus and no sulphur.

The Cedar Point Furnace, blown out in January, has been relined and repaired and is now running smoothly.

The Crown Point furnaces have been shut down for repairs and are now ready to start.

The Chateaugay Mine at Lyon Mountain has worked through the "horse" that had caused much apprehension and is now yielding as usual.

The iron mines at Mineville (Witherbees, Sherman & Co. and Port Henry Iron Ore Company) are showing a good output.

Foot-Guard for Frogs and Switches.

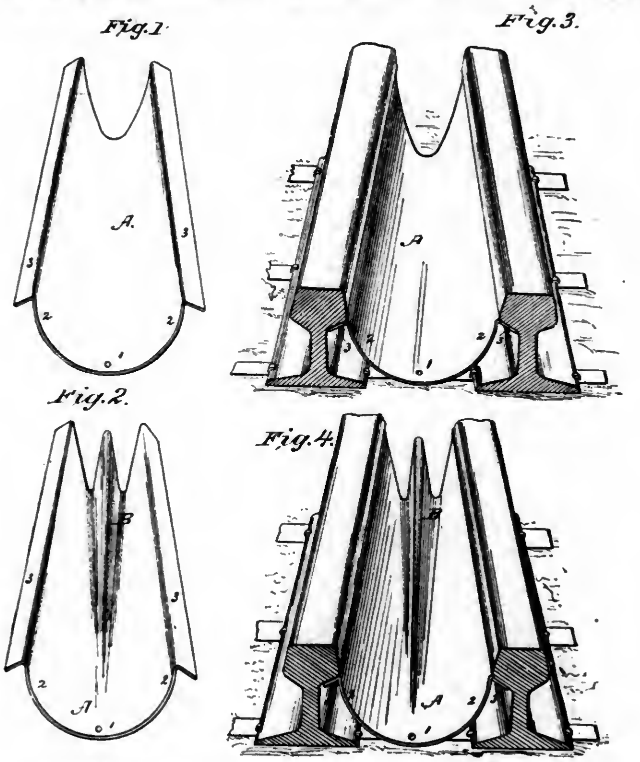
THE accompanying illustrations show a form of foot-guard for frogs and switches recently patented. The object is to fill the space in the frog, switch or guard-rail so as to make it impossible for a person to catch his foot or to trip, and at the same time to leave space for the wheel flanges; there is the further advantage that the accumulation of snow or ice is prevented.

The inventor describes his device as follows: "The foot-guard *A* may be made of sheet-iron, steel or any other metal of sufficient strength, or of paper or other composition, and may be made to fit any angle needed in the frog, switch-rails, guard-rails or other angles, and of a height to fit any rail used in building railroads. It has a bottom portion, 1, side wings 2, and lateral flanges 3, and is put in place by shoving it into the open space between the rails of the frogs, switch-rails, or rail and guard-rail from the wide end of the angle, with the longitudinal flanges so turned as to fit closely under the ball of the rail, the outer edge of the flange extending to the concave of the rail and the inner edge projecting even with the ball of the rail, the sides 2 extending downward and inward at 1 in

nearly a semicircular form, the bottom resting upon the ties and spiked or nailed to one or more of them. Its length must be governed by the angle of the frog, switch-rail or guard-rail. It must extend far enough into the narrow end of the angle to prevent the insertion of a foot in front of it, and far enough back to prevent the sole of the largest boot being caught under the ball of the rail.

"The general shape of the foot-guard, as seen when the flanges 3 on either are under the ball of the rail, is nearly a semicircle with the convex side downward, the angles being sharper at the narrow end and widening toward the other end, according to the angle of the rails.

"In the construction shown in figs. 2 and 4 there is a corrugation, *B*, rising in the center at the narrow end of the guard nearly as high as the sides, giving the end the form of the letter **W**, and this corrugation *B* slopes gradually toward the wider end of the foot-guard, when it entirely ceases or merges



EDWARD'S FOOT-GUARD FOR FROGS AND SWITCHES.

in the base of the guard having a flat rounded surface. This center corrugation should be of such height and the space between it and the sides such that it will not come in contact with the flange on the car-wheel.

"In the construction shown in fig. 3 the foot-guard is nearly semicircular in shape, with the longitudinal sides or flanges bent out at an angle to fit tightly under the ball of the rail.

"The construction shown in figs. 2 and 4 is like that shown in figs. 1 and 3, except that in the narrow end the center is doubled up, so as to form the corrugation, which slopes gradually toward the wider end, where it entirely ceases. This form is particularly intended for use where the rails are close, to prevent the foot from going down between the rails."

The patent, which is No. 367,609, dated August 2, 1887, has been granted to Mr. Edward P. Edwards, of Webster City, Iowa.

Manufacturing Notes.

THE Brownell & Wight Car Company is building a large addition to its shops in St. Louis.

THE contract for the new Belle Isle bridge at Detroit has been awarded by the City Council to the Detroit Bridge & Iron Works for $280,000.

THE Pond Engineering Company in St. Louis is very busy. The company has recently sold a number of the Lowe feed-water heaters and purifiers.

THE Armington & Sims Engine Company has bought the Monohassett Mill property at Providence, R. I. As soon as the plant can be transferred, the company will largely increase its facilities for building its engines.

IT is said that an English concern, the Moss Bay Hematite Steel & Iron Company, purposes establishing extensive steel works at a point near Seattle in Washington Territory, where there are extensive deposits of iron ore.

THE Smith, Beggs & Rankin Machine Company in St. Louis is building two stationary engines with 30 × 60 in. cylinders for the new Olive Street cable railroad in that city. These engines are expected to work up to 1,200 H. P.

THE La France Company in Elmira, N. Y., has just completed a double pumping engine for a new fireboat built for the city of Buffalo, N. Y. These pumps can throw ordinarily 4,000 gallons an hour, and can be worked up to 5,000 gallons an hour if necessary.

THE Atchison, Topeka & Santa Fé Company has ordered two locomotives of the Strong pattern. One, with six drivers, will be built at the Schenectady Locomotive Works, and the other, with four drivers for passenger service, at the Hinkley Locomotive Works in Boston.

THE St. Louis Car Company, a new concern, is building extensive works in St. Louis for the manufacture of street, cable and elevated railroad cars. The officers are: Daniel McAllister, President; P. M. Kling, Vice-President and Manager; William Lefmann, Secretary and Treasurer.

A SYNDICATE of iron manufacturers of Wheeling, W. Va., organized under the name of the East Chicago Steel Company, has leased for five years the Bessemer-steel plant at Hammond, Ind., just completed by the Chicago Steel Manufacturing Company. A blast furnace and rolling-mill are to be added to the plant.

THE Dickson Manufacturing Company in Scranton, Pa., is building 9 locomotives for the St. Paul & Duluth road and 2 shifting engines for the Brooklyn Bridge. The company recently shipped to Anaconda, Montana, a set of compound hoisting engines having cylinders 26 and 42 in. diameter and 72-in. stroke.

THE Rhode Island Locomotive Works in Providence have just completed a locomotive of the Forney pattern for the New York, Providence & Boston road. It has 15 × 20 in. cylinders and 56-in. drivers; the boiler is 44 in. diameter and the fire-box, for anthracite coal, 66 in. long. The total wheel-base is 22 ft. 7 in. and the weight 90,000 lbs. It is intended for service on the Pawtuxet Valley Branch.

THE Lawrence Machine Company, of Lawrence, Mass., has just been awarded the contract for one of the largest pumping plants ever planned in this country. The plant is for the city of Montreal, P. Q., and consists of four centrifugal pumps, each with a discharge opening of 24 in. diameter and capable of handling 18,000 gallons of water per minute, and four similar pumps of 15 in. discharge opening and a capacity of 7,000 gallons per minute. Thus the four 24-in. pumps have a combined capacity of 72,000 gallons per minute, 4,320,000 gallons per hour, 103,680,000 gallons or 386,000 tons of water per day of 24 hours, and the four 15-in. have a combined capacity of 28,000 gallons per minute or 1,680,000 gallons per hour. These pumps are contracted for by the Inundation Committee of Montreal, and are designed to pump the sewerage of the city over the walls and dykes now in process of erection, to protect the lower portions of the city from the annual inundation caused by the floods and ice gorges of the St. Lawrence River.

Marine Engineering Notes.

THE Union Iron Works in San Francisco recently launched the new steel steamer *Premier*, which is intended to run on Puget Sound for the Canadian Pacific Railway Company.

THE Quintard Iron Works in New York City have the contract for a triple-expansion engine for the new steamer *Chemung*, now building at Buffalo for the Union Line between that port and Chicago.

A NEW ferry-boat is nearly completed at San Francisco, for the South Pacific Coast Railroad; she is to run between San Francisco and Alameda, and will have a capacity of 2,500 passengers. The boat is 265 ft. long, 75 ft. beam over all, and 16 ft. depth of hold. The engines are built by the Fulton Iron Works.

THE Baltimore & Ohio Railroad is to have a new steam ferry-boat for transferring trains between Locust Point and Canton in Baltimore Harbor. This boat, which is named *John W. Garrett*, was launched from the Harlan & Hollings-

worth Company's yard in Wilmington, Del., August 2. The boat is 366 ft. long and 76 ft. wide over all, and will carry 15 passenger or 30 freight cars at a trip.

It is stated that the Cleveland Shipbuilding Company in Cleveland, O., has taken a contract to build two steel steamers for the Lackawanna Transportation Company. The new vessels are to be 275 ft. long, 38 ft. beam and 25 ft. hold, and are to run between Buffalo and Chicago.

The Cleveland Forge Company, of Cleveland, O., have received the contract to furnish the new steamer *Puritan*, of the Fall River Line, and the steamer building for the Providence Line with all their heavy forgings, such as shafts, cranks, pins, etc. The *Puritan's* main shaft will be 28 in. in diameter and weigh 42 tons, the largest shaft ever forged in America. Her beam strap will weigh about 19 tons, this being the largest one ever made. The Providence steamer's shafts will be 25 in. in diameter. The Cleveland Forge Company furnished the lake steamer *Owego* and her consort now building with shafts, cranks and pins. These steamers' cranks weigh 22 tons each.

The Old Colony Steamboat Company has let contracts for its new steamboat *Puritan*, which is to run on the Fall River Line between Fall River and New York. The *Puritan* will be larger than the *Pilgrim* of the same line, and will, it is claimed, be the largest steamboat for inland waters in the world. She will cost about $1,500,000 and will be finished early in 1889. Her length is to be 404 ft. at the water-line and 420 ft. over all, which is 30 ft. longer than the *Pilgrim*. The beam will be 52 ft. and 90 ft. across the guards, with a depth of hold of 21 ft. 4 in. She will have 355 state-rooms. The hull is to be constructed on the double-hull bracket-plate and longitudinal system, with the bottom divided into 50 water-tight compartments. In addition to these compartments, six water-tight bulkheads will extend to the main deck. The hull is to be built at John Roach & Sons' yard at Chester, Pa.; the upper-works, cabins, etc., by William Rowland, of New York.

The *Puritan* will have a compound-beam engine, having a high-pressure cylinder 75 in. diameter and 9 ft. stroke and low-pressure cylinder 110 in. diameter and 14 ft. stroke. The paddle-wheels will be feathering wheels, of the same pattern as those used in the *New York* of the Albany Day Line on the Hudson River. She will have 8 steel boilers, intended to carry a working pressure of 110 lbs. The engines will be built by the W. & A. Fletcher Company at the North River Iron Works in New York City.

Messrs. Robert Palmer & Sons at Noank, Conn., are building a new wooden steamboat for the Providence & Stonington Steamship Company, to run on the line between Providence and New York. The steamboat will have a frame of white oak, live oak and hackmatack and planking of white and yellow pine. The hull will have six water-tight bulkheads of 2-in. white pine. The length on water-line will be 345 ft.; over all, 357 ft. The breadth of beam will be 47 ft. 6 in.; breadth over guards, 85 ft. The depth will be 17 ft. 3 in.

The engines will differ from those of nearly all the boats running on Long Island Sound, which are of the beam pattern. They will be compound oscillating engines with high-pressure cylinder 56 in. and low pressure 104 in. diameter; both 11 ft. stroke. Both cylinders will have the Wheelock gridiron valve, and the valve-motion will be of the link type. The cylinders will be set at an angle of 100° with each other. Steam will be supplied by six boilers, 12 ft. 6 in. diameter and 20 ft. 3 in. long, each having three corrugated furnaces 4 ft. diameter and 7 ft. 6 in. long; the working pressure will be 130 lbs. The engines will have surface condensers. The paddle-wheels will be of the feathering type, 29 ft. diameter, with 12 buckets, each 14 ft. face and 4 ft. 6 in. wide. The engines are expected ot develop 4,500 I. H. P.; they have been designed by Mr. George B. Mallory, the company's Engineer.

The Strong Locomotive.

The Strong Locomotive Company is now building three locomotives of the Strong pattern for the Atchison, Topeka & Santa Fé Railroad. They are to be used on the fast express trains on the new extension to Chicago. One of these engines will have 19 × 26 in. cylinders and three pairs of drivers; the other two will have 18 × 24 in. cylinders and four 68-in. drivers.

A locomotive for the Michigan Central is also under way; it will have 18 × 24 in. cylinders and is to run on fast express trains between Chicago and Detroit. The company has several other orders on hand.

Proceedings of Societies.

American Association for the Advancement of Science.

The 36th meeting of the American Association for the Advancement of Science convened at Columbia College, New York, on Wednesday, August 10, about 1,000 persons being present. The President of the Association, Professor S. P. Langley, presented the President of the College, Dr. Barnard, who made a speech of welcome in the name of the Trustees of Columbia College.

The General Secretary, Professor Pettee, announced the addition to the Association of over 200 members since the meeting at Buffalo last year. Some 300 papers had been submitted to be read before the sections. As this was a greater number than could possibly be considered, it would be necessary for the committees to exercise some discrimination. As soon as organized the committees would make up the programmes for their respective sections for Thursday, and daily thereafter.

The Permanent Secretary, Professor Putnam, announced the death of 25 members during the year, including James Buchanan Eads, of New York; William B. Hazen, of Washington, and Edward L. Youmans, of New York. After adopting several unimportant changes in the constitution and electing a Vice-President for Section A—Mathematics and Astronomy—the general session adjourned.

The various sections at once assembled in their rooms and effected their organizations. These are the eight sections:

A—Mathematics and Astronomy: Vice-President, J. R. Eastman, of Washington; Secretary, Henry M. Paul, of Washington. B—Physics: Vice-President, W. A. Anthony, of Ithaca; Secretary, C. Leo Mees, of Athens. C—Chemistry, Vice-President, Albert B. Prescott, of Ann Arbor; Secretary, C. F. Mabery, of Cleveland. D—Mechanical Science and Engineering: Vice-President, Eckley B. Coxe, of Drifton: Secretary, George M. Bond, of Hartford. E—Geology and Geography: Vice-President, G. K. Gilbert, of Washington; Secretary, William M. Davis, of Harvard. F—Biology: Vice-President, W. G. Farlow, of Cambridge; Secretary, J. Henry Comstock, of Ithaca. H—Anthropology: Vice-President, D. G. Brinton, of Media; Secretary, Charles C. Abbott, of Trenton. I—Economic Science and Statistics: Vice-President, Henry E. Alvord, of Amherst; Secretary, W. R. Lazenby, of Columbus.

The sections then took up the abstracts of papers submitted to their judgment. Some were found too metaphysical and others too long, so they were either referred back to their authors for condensation or altogether rejected. Those accepted were submitted to the Council.

In the hall of Section B, devoted to physics, Professor W. A. Anthony, of Ithaca, spoke on "The Importance to the Advancement of Physical Science of the Teaching of Physics in the Public Schools." The principles of science should be spread broadcast. Not only boys but girls should receive such training, and young children could appreciate it. A properly conducted scientific education in the primary schools would teach children to avoid the mistake of attempting the impossible and be of great benefit to science. Grammar should be one of the last subjects for a boy to take up. Language should be taught by reading, not by rules. Geography should be taught to give familiarity with the form of the earth Beyond this the geography should be a book of reference. As soon require a child to learn the dictionary by heart as to learn the names of capes, rivers and islands as they are now taught. With regard to arithmetic, interest, discount and partial payments should be cut out of the course and given as part of a business training. Children in their earliest experiences have to do with heat, light, sound, movement and magnetism. Physics should be taught by calling attention to familiar facts and then explaining them.

"Engineering" was the subject of the paper read before Section D, devoted to mechanical science and engineering, by Mr. Eckley B. Coxe, of Drifton, Pa. Engineering, though the youngest of the professions, was already divided into civil, mining, mechanical and other branches. Another subdivision was taking place. To some engineers it was a science, to some a profession, to some a business. The business engineers, that is, men who would engage to build a bridge or do any other engineering work, furnishing plans and guaranteeing to accomplish certain results for a given sum of money, taking all risks, were a very important class. There is no agreement as to what advice should be given to the young men wanting a technical education. In medicine and law the course is prescribed, but when we come to engineering no unanimity is to be found. The great difficulty is that the field attempted

to be covered by engineering is too vast to come under one system.

With these and other equally interesting papers and resulting discussion thereon, the day was passed until evening, when the retiring President, Professor Edward S. Morse, gave an address on "Evolution," which was much appreciated.

SECOND DAY.

On the second day, August 11, the various section rooms were well attended, and though there was little discussion on the papers, that can be accounted for by the fact that, there was such a plethora of matter, little time for outside talk was left.

"A Method of Telephonic Communication Between Ships at Sea," was the title of a paper read by Dr. L. E. Blake before the section devoted to physics. He said that he thought the experiments and the whole scheme antedated all other methods which had been proposed for fog signaling by telephone at sea. The plan was as follows:

A sound-producing apparatus was to be attached to each vessel and to be worked under the surface of the water. In times of fog or at night signals intelligible by means of a code would be produced by it, which would be transmitted in all directions through the water with a velocity four or five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with a sound-receiving apparatus, which would take up out of the water the signals arriving from neighboring vessels. "All of us," said Dr, Blake, "remember when as boys in swimming how distinctly the sound of the striking of stones together under water was heard. Just so distinctly is it possible to send musical tones from one ship to another."

For steamships the sound-producing apparatus was designed to be a steam fog-horn or whistle, specially constructed to sound under water and to be heard at least six or eight miles. From the nature of its tone it would be easily distinguishable from other sounds, always more or less present under water, from breakers and waves. With such whistles, a Morse alphabet of long and short blasts and pauses was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell-buoys were to have a second bell added under water, while lightships, lighthouses and any headlands, might also be provided with submerged bells which could be rung from the shore when necessary; sailing craft, both large and small, would have bells, and since an ordinary locomotive bell could be heard at least two miles under water, such simple means would seem to afford sufficient limits for protection for such vessels.

"It is believed," said Dr. Blake, "that sufficient has been done to show that the complete solution of this interesting and valuable practical scheme will lie probably in the telephonic method described. By this method, in October, 1885, signals were transmitted and received 1½ miles on the Wabash River from a locomotive bell, around three or four windings of the river, so that the operators were out of each other's sight. The sound could not be heard through the air, yet with fair distinctness could be heard through the telephone."

"Color Blindness Among Railroad Employés" was the title of a paper read before the same section by Dr. William Thompson. Professor of Ophthalmology in the Jefferson Medical College of Philadelphia. He said that the conflict between the officers and the employés of the Reading Railroad, which has occupied the attention of the public and has threatened to produce a suspension of work on that road, had reopened the question of color blindness. In the recent demonstration Dr. Thompson was able to show that an engineman declared a red danger signal at a distance of two feet to be a green light and failed to classify the white, red, green and blue flags properly. In July last 25,158 employés were examined on the Pennsylvania lines east of Pittsburgh and Erie. Of these 481 were color blind, 661 with defective vision and 158 with defective hearing. The officers of the Pennsylvania Railroad and other railroads had adopted Dr. Thompson's system of examination.

Dr. Albert N. Leeds read two papers, the second on "The American System of Water Purification." He said that manufacturing towns increased in population with such rapidity that they soon found their local sources of water supply insufficient in quantity and dangerous to health from pollution by sewage and factory waste. The American system of water purification comprised three distinct features: Artificial aeration under pressure; precipitation of dirt, sewage, hardening constituents and coloring matters by harmless precipitants; mechanical filtration through filters capable of rapid reversal of current, and cleansing by mechanical means.

The section on Economic Science and Statistics listened to two important papers read by Professor W. O. Atwater in relation to the food question.

Professor D. S. Martin, of Columbia College, spoke on "The Geology of New York and its Environs" before the section on Geology and Geography. He pointed out the various geological formations which, like great waves, crop out all along the sea coast from the Alleghanies to the sea coast coming down to New York City. Geologists were not agreed upon the age of the rock which forms the backbone of Manhattan Island. He believed it to be archaic, or of the first order. Over Manhattan Island, 1,500 ft. higher than the Atlantic Highlands, an ice wave had swept from the north thousands of years ago and left the sandy deposit now on this and Long Island and Staten Island and portions of New Jersey. Before the period, the ice drift a river ran from the Housatonic Valley in Connecticut through the depression where the East River now is joined and the Hudson below New York Bay. Then together the streams flowed through flat lowlands to the sea, then 60 miles further out than now. The Palisades were then 700 ft. high.

The ladies of the Reception Committee tendered the members an informal reception in the Metropolitan Opera House in the evening, where many not previously acquainted became so. This reception was very largely attended.

THIRD DAY.

On the third day, August 12, the section on geology and geography gave up the whole of the day to a discussion of the report of the American Committee of the International Congress of Geologists. This was a task of greater or less limitations, as the section chose to make it, and they found time to pretty thoroughly go over the work of the International Congress at its Berlin session last year, criticising some parts of it with severity and giving some of it their hearty commendation. Many suggestions were advanced as to what should be done at the next session, which will occur in London.

Section I, on Economic Science and Statistics, gave up the day to statistical questions, three papers being read. The first, "The Testimony of Statistics as to our National Progress," was by Professor E. J. James, of the University of Pennsylvania; the second, "The Wealth of the Republic," was by Dr. C. S. Hill, and the third, "On the Rates of Interest Realized to Investors in the Bonded Securities of the United States Government," was by Professor E. B. Elliott. Being of an economic character, they aroused a considerable interest, and were well attended by both scientists and laymen. In his paper Professor James, after referring to Professor Atkins' papers read the preceding day, said: "In an examination of the long series of wage receivers whose wages are quoted in the New Jersey statement I fail to find more than a comparatively small per cent., counting in the whole number of laborers, who actually attained the figure of $600 in their income. Six hundred dollars per year means $2 a day for the days of the working year. There must be no days of sickness or leave of absence or vacation or strike, if the sum is to be accumulated by working at $2 a day. Now, $2 per day is very much more than the average unskilled laborer can earn, and if skilled mechanics often earn much more we must remember that their working season is often very short. The amount of comfort or elegance which can be obtained from $2 per day, if one has to support five persons out of it, you can easily reckon out for yourselves. The average earnings of all the laborers reported in the Pennsylvania statistics was less than $400 per annum. The average weekly wage in the coal trade was only $6.20, or $325 per annum. The average weekly wage in foundries employing 17,000 men was less than $9; in the Bessemer steel works less than $8.50; in hosiery and knit goods less than $5.

"We believe that this is a grave social problem which will require the most careful investigation and cautious action, if it is to be solved without seriously disturbing our social order. The conditions of life are becoming more severe as the years roll on. The prizes open to the successful one are growing larger, but the number of blanks is also rapidly increasing."

In the section on Physics, Professor Elias S. Ries read a paper on The Electric Current as a Means of Increasing and Varying the Tractive Adhesion of Railroad Motors and other Rolling Contacts.

In the afternoon most of the members joined in an excursion around the harbor. In the evening many attended a reception given by the Torrey Botanical Club.

On Saturday, August 13, there was no meeting, the members generally joining in one of the two excursions provided

for their entertainment. One of these was up the Hudson River to West Point, the other down the Bay to Long Branch.

FOURTH DAY.

The arrangements for the fourth day, Monday, August 15, provided for the amalgamation of the mechanical science and engineering section with that devoted to economic science and statistics for the reading and discussion of papers relating to Isthmus Transit. This session was largely attended, and seemed to attract a great deal of attention. It was opened by Commander H. C. Taylor, U. S. N. who read a paper entitled The General Question of Isthmian Transit. This paper was in part a historical account of the various plans for isthmus transit, and in part a comparison of the merits of the Panama Canal, the Tehuantepec Ship Railroad and the Nicaragua Canal—decided preference being given to the Nicaragua plan.

Climatic and Sanitary Notes on the Nicaragua Canal Route was the next paper, read by Surgeon John F. Bransford, U. S. N. He said that the line of mountains forming the continental "divide" in Central America passes through Nicaragua in a northwesterly direction. This brought it across the course of the northeast trades, and the wind rushed over the hills and through the gaps to the Pacific. This breeze, ventilating and drying the country and lowering the temperature, was the great sanitary agent in Nicaragua. By the time the wind reached the lake basins its surplus moisture was gone. The southeast wind predominated during the rainy season. The temperature of Nicaragua was equable. The extreme variation on the line of the canal recorded by Childs was of 23°, his maximum being 91°. The rainfall, based on the records of nine years, showed an average of 64.42 inches. The country, generally, he considered healthy, and residents there needed only to take the ordinary precautions required in all tropical climates. The supply of fresh provisions, beef and fruit, is abundant, and the drinking water is good from one end of the line to the other.

Civil Engineer R. E. Peavy read a paper called "The Engineering Features of the Nicaragua Canal. He said that the distance from ocean to ocean by the proposed route was 169.8 miles. Of this distance, however, only 40.3 miles were actual canal, the other 129.5 miles being free navigation through Lake Nicaragua, the Rio San Juan and the valley of the San Francisco. The lake and river must form a part of every canal route through Nicaragua and the location as a whole was the result of Civil Engineer Menocal's complete and exhaustive personal knowledge of the entire country from ocean to ocean. Of the 40.3 miles of actual canal, about 27 miles would be excavation pure and simple, while the remaining 13 miles would be largely if not entirely excavated by dredges.

"There are two features of this project which to many who have not made such structures a study cause a question of safety to arise. One is the dam, which at one stroke gives us 64 miles of river navigation, and the other is the embankment, which at a second stroke gives us over 8 miles of lake navigation and completely solves, for that portion of the canal from the dam to the divide (13 miles), the important problem of protection from surface drainage. But they are small when compared with many others scattered about the world, and serving much less important purposes than the ones under consideration. Beside the Quaker Bridge dam they are pigmies.

"The necessary machinery for moving the locks and culvert gates, for hauling the ships in and out of the locks, for electric light and other purposes, will be worked by hydraulic power furnished by the locks themselves. Locks are absolute sources of safety. Much has been said about the harbors at the termini of the Nicaragua route. It may be remarked that there is no practical route for a canal across the American isthmus that has good harbors, and it is believed that those at the termini of the Nicaragua Canal can be made first-class at less cost than those of any other route."

This is the estimated time of transit through the canal by steamer, as given by Mr. Peavy: 38.98 miles at 5 miles an hour, 7 hours 48 minutes; 8.51 miles on the San Francisco basin at 7 miles an hour, 1 hour 48 minutes; 64.54 miles on the San Juan River at 8 miles an hour, 8 hours 4 minutes; 56.50 miles on the lake at 10 miles an hour 5 hours 39 minutes; time allowed for passing 7 locks at 45 minutes each, 5 hours 15 minutes; detention in narrow cuts, 2 hours; total, 30 hours.

J. W. Miller, General Manager of the Providence & Stonington Steamship Company, read a paper called Historical and Geographical Notes Concerning the Nicaragua Canal Route.

At the general evening session a formal welcome to the Association was given by the New York Academy of Sciences.

Professor Henry Drummond, of Glasgow University, Scotland, lectured on The Heart of Africa.

Professor Thomas A. Edison, being busy at Menlo Park, was unable to attend the meeting, and therefore intrusted to Professor Baker, of the University of Pennsylvania, who read it before the Physics Section, a paper describing a machine for producing electricity direct from fuel. To do this, says the paper, has long occupied the close attention of inventors. Could the enormous energy latent in coal be made to appear as electric energy, with reasonable economy, the mechanical methods of the entire world would be revolutionized and another grand step of progress would be taken.

Quite recently Lord Rayleigh concluded that from a copper-iron couple a conversion of not more than of the coal energy could be hoped. As a heat engine, therefore, the thermo cell can have no higher efficiency than Carnot's reversible engine. Another line of investigation suggested itself to Mr. Edison. It has long been known that the magnetism of metals is markedly affected by heat. Nickel loses its power of being magnetized at 400°, iron at a cherry red heat, and cobalt at a white heat. Whenever a magnetic field varies in strength in the vicinity of a conductor a current is generated in that conductor; so it occurred to him that by placing an iron core in a magnetic circuit and by varying the magnetizability of that cone by varying its temperature, it would be possible to generate a current in a coil of wire surrounding the core. This idea constituted the essential feature of the new generator, which therefore he calls a "pyro-magnetic generator of electricity."

The principle was first applied to the construction of a simple form of electric engine, a "pyro-magnetic motor." This consisted of a permanent magnet, having a bundle of small tubes made of thin iron placed between its poles, and capable of rotation about an axis perpendicular to the plane of the magnet. By suitable means hot air passes through these tubes, so as to raise them to redness. By a flat screen placed across this bundle of tubes and covering half of them, access of the heated air to those tubes is prevented. When this screen is so adjusted that its ends are equidistant from the two legs of the magnet, the bundle of tubes will not rotate, since the cooler and magnetic portions beneath the screen will be equidistant from the poles. If the screen be turned about the axis of rotation, so that one of its ends is nearer one of the poles and the other nearer the other, then rotation of the bundle will ensue. The first motor constructed on this principle was heated by means of two small Bunsen burners, and it developed about 700 foot-pounds a minute. A second and larger motor is now about finished, which will weigh about 1,500 lbs., and is expected to develop about three H. P. In both these machines electro-magnets are used in place of permanent magnets, the current to energize them being derived from an external source. In the larger machine the air for combustion is first forced through the tubes to cool them, and then is forced into the furnace at a high temperature.

The construction of a machine of sufficient size to demonstrate the feasibility of producing continuous currents on a large scale was at once begun and has just been completed. The new machine consists of eight elements, each the equivalent of the device already described, arranged radially about a common center. The machine is placed on top of any suitable furnace, fed by a blast, so that the products of combustion are forced up through the armature in turn. The potential difference developed by this dynamo depends upon the number of of turns of wire on the armature coils, the temperature difference in working, the rate of temperature variation, and the proximity of the maximum point of effect. The results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyro-magnetic dynamo will be at least equal to and probably greater than that of any of the methods in present use. But the actual output of the dynamo will be less than that of an ordinary dynamo of the same weight. Since, however, the new dynamo will not interfere with using the excess of energy of the coal for warming the house itself, and since there is no attendance required to keep it running, it would seem to have already a large field of usefulness for it. By using the regenerative principle in connection with it great improvement may be made in its capacity, and its practical utility may equal the interesting scientific principles which it embodies.

The paper received close attention and was much discussed, a pronounced interest in the outcome of the pending experiments being manifested.

FIFTH DAY.

On the fifth day, August 16, the Association met in general session and passed upon the reports of several committees and the recommendations of the Council. These latter embraced the election of these officers:

President—Professor J. W. Powell, of Washington, Director of the United States Geological Survey.

Vice-Presidents, (Chairmen of Sections)—Mathematics and Astronomy, Ormond Stone, of the University of Virginia; Physics, A. A. Michaelson, of Cleveland; Chemistry, C. E. Monroe, of Newport; Mechanical Science, Calvin M. Woodward, of St. Louis; Geology and Geography, George H. Cook, of New Brunswick; Biology, C. V. Riley, of Washington; Antropology, C. C. Abbott, of Trenton; Economic Science and Statistics, C. W. Smiley, of Washington.

Permanent Secretary—F. W. Putnam, of Cambridge, Mass.

General Secretary—J. C. Arthur, of Lafayette.

Secretary of the Council—C. Leo Mees, of Athens.

Treasurer—William Lilly, of Mauch Chunk.

Auditors—Henry Wheatland, of Salem; Thomas Meehan, of Germantown.

Cleveland was selected as the place of the next meeting, and the fourth Wednesday in August as the date. Several resolutions were adopted. In one of them President Cleveland was asked to at once appoint a permanent Superintendent of the Coast and Geodetic Survey. In response to another a committee to memorialize Congress on the preservation of archaeologic monuments on the public lands was appointed, and the President of the Association was asked to appoint a committee to devise methods for securing a reduction of the duties on scientific books and apparatus. Congress was asked to establish a bureau of standards by which the accurate standards of measure shall be constructed for electricity, heat, light, etc., and arrangements made for the issue of authentic copies. In response to a letter from Professor Cleveland Abbe, meteorologist of the Smithsonian Institution, Congress was asked to publish the "Index to the Literature of Meteorology," prepared by the Chief Signal Officer.

The members then separated to the various sections, where a large number of papers were read.

Before the Economic Section Professor E. J. James, of the University of Pennsylvania, gave his views on Manual Training in the Public Schools from an Economic Standpoint. He thought the question of manual and industrial training the most important educational topic now before the country. "The general introduction into our public schools," said he, "of systematic training in the underlying principles of the handicrafts is the next great step in the development of our educational system—a step for which we are now ready, and which should be taken immediately." The paper was an elaboration of this idea.

Yan Phou Lee, of New Haven, Conn., spoke on The Chinese Question from a Chinese Standpoint.

Professor George F. Kunz detailed some recent explorations made with a view to answering the question: Is there a Diamond Field in Kentucky?

J. R. Haskell discussed the National Armament before the Chemistry Section. The gun of the future, he said, would be multicharge, using slow powder in the breech and quick powder in the chambers.

The Biologic Section adopted a resolution approving the proposition to erect in New York City a monument over the remains of Audubon the ornithologist.

In the evening a reception was given by the Local Committee, preceded by closing exercises in which the thanks of the visitors to the Local Committee and to Columbia College were heartily expressed in several very earnest speeches. The friends of Mrs. Erminie A. Smith, of Jersey City, N. J., who was during her life the only woman ever elected to a position in the Association, gave an opportunity to any who wished, to contribute to the Smith Memorial Fund, for the purpose of putting a window in a church in that city in honor of her memory.

The members of the Association now number 721, about 20 having joined during the session as life members.

The fifth day completed the business of the session, but it did not fulfill the pleasure plans of the scientists. Several excursions were arranged, one party visiting Blackwell's Island, another made a geological exploration of Bergen Ridge and the Palisades. A third accepted an invitation from Lieut. E. L. Zalinski to go to Fort Lafayette and witness the firing of the dynamite gun. Other excursions took place to Saratoga and Lake George, Lake Champlain, and the Adirondacks.

Over 250 papers were presented at this meeting, many of them of great value. We only regret that the unavoidable limits of space prevent us from giving a much fuller summary than has been presented above; and also from presenting abstracts of a number of the papers which were read.

American Institute of Mining Engineers.

THE 48th meeting of this Institute consisted of an excursion in which quite as large a number of members joined as could be expected for so long a trip. The members left Chicago July 1 and went to Denver, Pueblo, Salt Lake, Butte City, Helena and the Yellowstone Park, reaching Duluth on their return July 24. Stops were made at Salt Lake, Butte City and Helena, and the members were hospitably entertained at each of those places. At Butte City, the Anaconda Mine and the great smelting works near by were visited. At Duluth, a number of members, who came to join in the meeting there, were found.

THE DULUTH MEETING.

The Duluth (49th) meeting began on Monday, July 25, when the opening session was held in the new Opera House. Addresses of welcome were made by Mayor J. B. Sutphin and Mr. William F. Phelps, Secretary of the Chamber of Commerce, and suitable acknowledgments were offered in reply by Mr. John Birkinbine, Vice-President of the Institute and acting President for this meeting, and by the Secretary; after which Mr. Birkinbine presented a paper on the Progress of the Lake Superior Region. This was a very long and exhaustive presentation of the present condition and capacities of the region.

In the afternoon an excursion to the Dalles of the St. Louis River was successfully carried out.

At the evening session, held in the parlor of the Duluth Boat Club House, Mr. Birkinbine gave the conclusion of his elaborate paper on the industries of the region. The remainder of the evening was occupied with a most interesting paper by Mr. Per Larsson, of Iron Mountain, Mich., on the Chapin Mine in the Menominee Range. This paper derived special importance from the circumstance that the Chapin, one of the great producing iron mines of that range, was near being ruined by caves, resulting from the attempt to employ the Nevada system of square timbering to hold open the immense stopes, and has been rescued by the introduction of a system of solid filling. The session was concluded with the reading of a Note on the Region North of Vermilion Lake District, by Theodore B. Comstock, Champaign, Ill.

Tuesday was occupied with an excursion to Two Harbors and the Vermilion mines of the Minnesota Iron Company.

The third session was held in the rooms of the Board of Trade on Wednesday morning, July 27, when the following papers were read and discussed:

The Iron and Steel Industry in Canada; J. H. Bartlett, Montreal, Canada.

Two Conditions of Phosphorus in Iron; Prof. B. W. Cheever, Ann Arbor, Mich.

Experiments Illustrating the Descent of the Charge in an Iron Blast Furnace; Prof. R. H. Richards and R. W. Lodge, Boston.

The following papers were read by title:

A Deposit of Bauxite; Edward Nichols, Hermitage, Ga.

Mode of Deposition of the Iron Ore of the Menominee Range; John Fulton, Cambria, Pa.

Method of Mining in the Menominee Range; John Fulton, Cambria, Pa.

Topographical Models and their Construction; J. H. and E. B. Harden, Phœnixville, Pa.

The Incline Railway at Lookout Mountain; W. H. Adams, New York City.

The Lead, Zinc and Copper Reduction Works of the United States; C. Kirchhoff, Jr., New York City.

Wire Rope Haulage; F. C. Roberts, Philadelphia, Pa.

Silicon Determinations in Blast-Furnace Cinder; Clemens Jones, Hokendauqua, Pa.

Coal Mining in Utah; C. A. Ashburner, Pittsburgh, Pa.

Further Notes on the Silver Plant; Ellen H. Richards, Boston, Mass.

The Segregation of Copper-Silver Alloys; F. F. Clausen, New Orleans, La.

Inorganic Standards for the Calorimetric Carbon Test; Theodore W. Robinson, Joliet, Ill.

A Crystalline Sub-Sulphide of Iron and Nickel; J. B. Mackintosh, Bethlehem, Pa.

Carbonate Iron Ores at Enterprise, Miss.; Alfred T. Brainerd, Birmingham, Ala.

The Gogebic Mines; R. A. Parker, Hurley, Wis.

The Vermilion Lake Mines; T. H. Hulbert, Duluth, Minn.

Twenty Years' Progress in the Concentration of Sulphuric Acid; W. H. Adams, New York City.

Some 30 new members and associates were elected at this session, and after the passage of the usual resolution of thanks the meeting was adjourned.

A sail around the harbor of Duluth in the afternoon, and a reception in the evening in the Hall of the Board of Trade, concluded the exercises at Duluth.

On Thursday morning, July 28, the members left Duluth and took a train over the Northern Pacific to Ashland, Wis. On the way a short stop was made at the point where the Ashland Furnace Company is putting up a new charcoal furnace, 60 ft. high with 12-ft. bosh.

After reaching Ashland the party saw the great ore docks, took a sail around the harbor and were entertained by the citizens of Ashland in the evening.

On the following day, July 29, the members took a special train to Hurley, Wis., and from that point as a center proceeded to examine the mines of the new Gogebic iron region. With this excursion and examination the meeting closed, and the members dispersed.

Master Car & Locomotive Painters' Association.

THE 18th annual convention of this Association will be held at the Grand Central Hotel in New York, beginning on Wednesday, September 14, at 10 A. M.

Members desiring to attend and secure rooms at the hotel should apply to the Chairman of the Committee, Alexander Campbell, Manhattan Railroad, New York.

The following list of subjects will be brought before the convention, being introduced by the committees to whom they have been assigned. It is hoped that each member of a committee will be prepared to report fully on the subject, and if unable to be in attendance at the meeting, forward their report to the Secretary, Mr. Robert McKeon, Kent, Ohio, by September 8:

No. 1. It is generally admitted that scarcely two Samples of Japan of Different Manufacture will give like results as to Drying and Binding Qualities. Why should there be such a Variation, and can we not have a Standard of Specifications as to Drying and Binding? In what way shall such a Standard for Japan be determined? Byron Stanbury, Union Pacific, Omaha, Neb.; Alex. Campbell, Manhattan Elevated, New York.

No. 2. Does the addition of Japan to Raw Linseed Oil Retard in Drying if used in Excessive Quantities, and what Variation is there in the Drying Qualities of Japans, when mixed with Raw Linseed Oil? M. W. Stines, Barney & Smith Manufacturing Co., Dayton, O.; A. E. Barker, Chicago & Northwestern, Chicago; R. W. Scott, Delaware Car Works, Wilmington, Del.

No. 3. What is the Maximum Amount of Japan that can be used with Safety, and the Proportion to Raw Linseed Oil? Jos. J. Murphy, Louisville & Nashville, Louisville, Ky.; H. Libby, Charles River, Boston, Mass.; Wm. E. Hibbard, Boston & Albany, Mass.

No. 4. What Quantity of Oil Paint composed of Metallic Paint, Linseed Oil and Japan, should constitute a Good Coat to the Square Yard of Surface, Amount in Weight and also Measure? F. S. Ball, Pennsylvania Railroad, Altoona, Pa.; M. L. Sims, East Tennessee, Virginia & Georgia, Atlanta, Ga.

No. 5. Would it be more Economical for the Painter to Manufacture his own Japan, or continue to use that of the Manufacturer? Geo. O. Widner, late of Lake Shore & Michigan Southern, Buffalo, N. Y.; H. M. Billings, Pittsburgh, Cincinnati & St. Louis, Columbus, O.

No. 6. Management of the Railway Paint Shop. E. L. Bigelow, Baltimore & Ohio, Baltimore, Md.

No. 7. What Constitutes the best Priming Coat of Paint for Locomotives and Tanks? Jno. S. Atwater, Hinkley Locomotive Works, Boston, Mass; F. M. Widner, New York, Lake Erie & Western, Buffalo, N. Y.; C. C. Wood, Pennsylvania & New York, Sayre, Pa.

No. 8. What is the Best Method of Mixing and Grinding Car-Body Colors to Ensure the Greatest Durability? Jacob Hoesly, Pennsylvania Railroad, Meadows Shops, N. J.; Robert McKeon, New York, Pennsylvania & Ohio, Kent, Ohio; John Rattenbury, Chicago, Rock Island & Pacific, Chicago, Ill.

No. 9. Causes of Iron Rusting under the Priming Coat of Paint and the Effect Rust has on Paint? A. J. Bishop, Cleveland, Columbus, Cincinnati & Indianapolis, Delaware, O.; C. C. Young, Chicago, Rock Island & Pacific, Trenton, Mo.

No. 10. Is it Advisable to Paint the Inside (water space) of an Engine Tank to protect it, and what Material would you consider it best to use? Samuel Brown, Old Colony, Boston, Mass.; E. E. Earl, Northern Pacific, St. Paul, Minn.

By resolution passed at the last convention in Chicago, each member was requested to prepare three panels, one each of Tuscan red, straw color and olive brown, according to their own formula, expose them to the weather and report results in writing at this convention.

Foremen painters of all car and locomotive shops are invited to attend the convention.

National Electric Light Association.

For the following report of the Boston convention we are largely indebted to the courtesy of the *Electrical World*.

The convention was called to order on Tuesday, August 9, at 10:30 A. M., by President Morrison. After a short address setting forth the objects of the meeting the President introduced Mayor O'Brien, of Boston, who welcomed the members to the city.

The report of the Secretary and Treasurer was then read, which shows a balance of $842 in the treasury of the Association.

Mr. Arthur Stuart then read the report of the Legal Committee and Committee on Patent Legislation. The report recommended the establishment of a patent court to decide questions which are now subject to a scattered jurisdiction; and it also advocated appointment and promotion similar to that pursued in the Army and Navy, together with the pensioning of the examiners after a service of a certain length. In order to carry out these measures and bring them properly before Congress, the report suggested that the next meeting be held at Washington.

The report of Committee on Revision of By-Laws, I. J. De Camp, Chairman, was then read. After one amendment, allowing four representatives of one company to become members of the association instead of three, the report was made a special order for the Thursday session.

Mr. A. V. Garratt read the report on Wire Gauge, which was accompanied by a printed table. Mr. Garratt gave an account of the various authorities consulted in the construction of the table. After discussion by Mr. C. O. Mailloux and Dr. Moses, the question was made a special order for Thursday.

The Secretary then read the report on Proper Insulation of Wires and Proper Installation of Electric Light Plants.

The Committee consisting of Profs. E. J. Houston and W. H. Marks, Mr. Carl Hering and Mr. M. M. Garver reported that on account of lack of funds no experiments would be undertaken, but they formulated a code of tests for wires. On motion of Mr. W. W. Leggett, the report was laid on the table.

At the opening of the afternoon session, Mr. M. M. Slattery presented a report from the Committee on Electric Distribution by Means of Alternating Currents. The report was discussed by Mr. S. H. Duncan, Dr. Moses, Messrs. Kimball, De Camp, Smith and others and accepted.

Mr. E. R. Weeks then read a forcible paper on the subject of Electrical Education.

An invitation from the Boston Electric Club to visit Nahant, Lynn and Point of Pines by boat was received.

SECOND DAY.

On the second day Lieutenant Murdock, U. S. N., read a paper on Electric Light Outfit for Cruisers, which was followed by a brief discussion.

The resignation of Mr. Morrison, as President, was tendered, but was not accepted.

Dr. L. Waldo described some interesting apparatus for wire bending tests and gave data in regard to silicon-bronze wires.

Invitations to visit and inspect plant were read from the Meigs Elevated Railroad and the New England Telephone & Telegraph Company.

Mr. C. Cooper's resignation as Treasurer was accepted with regret.

The afternoon and evening were given up to the steamboat excursion, which closed with a dinner at Point of Pines.

THIRD DAY.

On the third day a large portion of the morning session was devoted to a discussion of various constitutional amendments. Among the speakers were Mr. De Camp, Dr. Moses and Mr. Phelps.

The report of the Committee on Wire Gauge was then taken up and briefly discussed. On motion of Mr. Phelps, it was received with the idea that the members should do as much as they could to encourage the making and ordering wire on the metric system.

At the closing session in the afternoon, an interesting paper was presented by Mr. C. O. Mailloux, on Storage Batteries.

Mr. A. Reckenzaun, of England, read an important paper

on Electricity as a Motive Power, discussing not only the subject of storage batteries, but their use with electric motors in propelling street-cars, launches, etc.

The papers were an epitome of work in this field to date, and contained a variety of striking figures. They were discussed together.

Messrs. S. A. Duncan, T. C. Smith and W. W. Leggett were chosen members of the Executive Committee, to succeed F. A. Gilbert, S. F. Holbrook and Dr. O. A. Moses, resigned.

Pittsburgh was chosen as the place for holding the next convention, in February, 1888.

The meeting closed with a brief talk, started by Dr. Leggett, on the underground question.

American Water-Works Association.

THE annual convention of this Association began in Minneapolis, Minn., July 13. At the opening session President B. F. Jones made his annual address, dealing with the question of pure water for the future.

The customary addresses of welcome were received and responded to. Mr. Y. Nakajinni, a Japanese engineer now visiting this country, was chosen an honorary member. Several new members were admitted.

Secretary J. H. Decker then read his brief annual report, showing 180 active and 51 associate members. The Association spent $675 during the year and received $905.

At the afternoon session the following papers were read: Ground Water as a Source of Supply; A. C. Sekell. Private Water Companies; H. F. Dunham. Recording Gauges; Charles A. Hague. There was a discussion on the use of Revolution Counters in computing pumpage.

An evening session was held, at which there were discussions on the Basis of Taxation of Water-Works Property and on the Relative Economy of Management by Private Companies and Municipal Corporations.

On the second day papers were read as follows: Natural Filtration; G. W. Pearsons. Filtration or Subsidence; J. D. Cook. Classification and Purification; M. Gardner. There was a long discussion on Filtration and the use of wells adjoining river supplies.

At the afternoon session three papers were read: Fungus or Mossy Growths; S. McElroy. Reservoirs, Open or Closed; G. E. Beach. Legal Aspects of the Water Question; G. E. Beach.

After the session the members visited the Falls of Minnehaha in carriages.

On the third day only one paper was read, on Property in Water, by A. H. Denman.

It was decided to print this paper of Mr. Denman and his treatise on the legal points in pamphlet form. A committee was appointed to prepare suitable eulogies on deceased members.

It was decided to hold the next Convention in Cleveland, O., April 13, 1888. The following officers were elected for the ensuing year:

President, J. T. Fanning, Minneapolis, Minn.

Vice-Presidents, J. M. Diven, Elmira, N. Y.; N. J. Milner, Birmingham, Ala.; J. W. Henion, Minneapolis, Minn.; J. P. Donahue, Davenport, Ia.; H. W. Ayers, Hartford, Conn.

Secretary and Treasurer, J. H. Decker, Hannibal, Mo.

Finance Committee, A. H. Denman, Des Moines, Ia.; B. Espy, Wilkesbarre, Pa.; C. N. Priddy, Leadville, Col.

After disposing of the routine business, the Convention adjourned.

The meeting closed by excursions to St. Paul and Lake Minnetonka; the annual banquet was held at the Lake.

Engineers' Club of Kansas City.

IN place of the regular meeting of August 1, this Club took an excursion on July 30, to Sibley, Mo., where the Chicago, Santa Fé & California road is to cross the Missouri River, by invitation of Mr. Octave Chanute, Consulting Engineer of the works. There were, including ladies and other invited guests, 52 in the party, which was taken to Sibley in a special car on the Wabash road. Mr. I. F. Wallace, Resident Engineer at the bridge, conducted the visitors to the scene of operations.

After examining the plans and materials and the arrangements for prosecuting the work, they were served a lunch. Subsequently, a few of the more adventurous members of the party descended into the caissons, from which they emerged, a few moments later, drenched and almost exhausted. They declared that the temperature of the outside atmosphere at 97° was wintry in comparison with the temperature (110°) which they experienced during their short stay in the caissons.

In the afternoon the guests were conducted aboard the contractor's steamboat by Mr. Sooysmith and took a short trip on the river.

The bridge proper will consist of 3 spans of 400 ft. each, 1 span of 250 ft., 1 span of 200 ft. and 2 spans of 175 ft. each, making the entire length of the main structure 2,000 ft. It will be approached on the north side by an iron trestle 900 ft. long and a wooden trestle 3,700 ft. long, making the length of the bridge, with approaches, 6,600 ft. in all.

Western Society of Engineers.

A REGULAR meeting was held in Chicago, July 5, at which Professor A. N. Talbot, of the University of Illinois, was elected a member.

A resolution was adopted authorizing the President to appoint delegates to a Convention of Engineering Societies, whenever such a convention should be called, as proposed by the Board of Managers of the Association of Engineering Societies.

The Librarian announced the receipt of several new books, and was authorized to prepare and publish a catalogue of the library.

Mr. John Lundie read a paper—Notes on Concrete. This paper was discussed by Messrs. Artingstall, Williams, Gottlieb and others.

Council of Engineering Societies.

THE Council of Engineering Societies on National Public Works has issued the following circular:

"The Executive Board finds such a growing sentiment in favor of a broad and general consideration of the question of the policy to be pursued toward the public works of the country, both in the legislative and executive features, that it feels renewed encouragement in continuing its labors.

"The various societies are expected to continue their committees and be ready to consider any matter that may be laid before them; meantime any work which these committees can do, or any suggestions and results which they may lay before the Executive Board, will promote the general objects of this organization.

"A cordial invitation is extended to all societies, not now represented in the Council, to appoint committees on National Public Works. The Secretary will publish all necessary information."

The officers of the Council (which is an entirely different body from the Association of Engineering Societies) are: President, L. E. Cooley; Secretary, John Eisenmann, No. 44 Euclid Avenue, Cleveland, Ohio.

American Institute.

THE Polytechnic Section of the American Institute purposes enlarging its field of operation and popularizing its work by adding during the coming winter a course of familiar lectures on scientific subjects.

These lectures will be given on the first and third Thursday evenings in each month at the Institute Rooms in New York. The subjects will be announced from time to time. The regular meetings of the Section are devoted to short papers, discussions and exhibition of new inventions.

American Society of Mechanical Engineers.

THE Secretary, Mr. F. R. Hutton, gives preliminary notice of the annual meeting of this Society, which is to be held in the City of Philadelphia, Pa., in the latter part of the month of November. The exact date and details will be the subject of a later announcement, as usual. Applications for membership to take effect at this meeting should be in the Secretary's hands by October 1, to allow for the correspondence required by them under the new form of blank. To admit also of a little earlier distribution of the printed papers in advance of the meeting, to allow more time for the preparation of discussions upon them, which has been asked for, the MSS. of papers for this meeting should be forwarded to the Publication Committee before September 24.

The Secretary would like to have authors forward at once to him the titles of papers for the meeting, in advance of the prep-

aration of their text. This plan avoids the embarrassment to the Secretary and to authors which follows when the docket has to be kept in uncertainty up to the very limit of date. The Secretary's office is at No. 280 Broadway, New York City.

Master Car-Builders' Association.

The following notice has been issued from the office of the Secretary, No. 45 Broadway, New York.

"The circulars and cards for the letter-ballots ordered by the Master Car-Builders' Association at the Minneapolis convention have all been sent to members of the Association by mail. If any member has not received the circular, he will confer a favor on the Secretary by informing him at once.

"The subjects of the letter-ballots are: 1. Standard Type of Coupler. 2. Rigging for Non-Automatic Draw-Gear. 3. Standard Axles, Journal-Box, etc., for cars of 60,000 lbs. capacity. 4. Standard Sizes of Lumber for Freight Cars."

PERSONALS.

Mr. E. M. Leuffer is Chief Engineer of the new Buffalo & Geneva road in New York.

Mr. J. H. E. Waters is Chief Engineer of the projected Silverton Railroad in Colorado.

Mr. Albert M. Stahl has been appointed Assistant Naval Constructor in the United States Navy.

Mr. Edward P. North has been appointed Chief Engineer of the New Haven & Derby Railroad.

Mr. Joseph Broaddus is Chief Engineer of the projected Chicago, Kansas & Arkansas road in Kansas.

Dr. H. V. Ferrel, of Williamson County, has been appointed a member of the Illinois State Board of Health.

Mr. G. H. Randall has been appointed City Engineer of Fond du Lac, Wis., in place of N. Boardman, resigned.

Mr. D. H. Rhodes has been appointed Chief Engineer of the Wichita & Western Railroad, with office at Wichita, Kansas.

Mr. W. J. Murphy succeeds Mr. Benjamin Thomas as General Superintendent of the New York, Lake Erie & Western.

Mr. L. F. Billinger, C. E., has been appointed Professor of Engineering and Architecture in Norwich University in Vermont.

Mr. J. C. Turner, of Winchester, Va., is Chief Engineer in charge of the surveys of the projected Louisville, Cincinnati & Virginia road.

Mr. Horace G. Burt is appointed Chief Engineer of the Chicago & Northwestern road. He was recently Superintendent of the Iowa Division.

George G. McWhorter, Edward J. Vann and **William Hines** have been appointed Railroad Commissioners of Florida by the Governor of that State.

Mr. J. M. Meade has been appointed Assistant Engineer of the Eastern Division of the Atchison, Topeka & Santa Fé road, with office at Topeka, Kansas.

Mr. E. H. Johnson has retired from the office of Chief Engineer of the Chicago & Northwestern road, but will remain with the company as Consulting Engineer.

Chief Engineer A. H. Able, U. S. N., has been ordered on special duty in connection with the new cruisers now building at Cramp & Sons' shipyard in Philadelphia.

Mr. W. H. Baker has been appointed Assistant Engineer of the New Mexico Division of the Atchison, Topeka & Santa Fé road. with office at Las Vegas, New Mexico.

Mr. W. Gessler has been appointed Master Mechanic of the Southwestern Division, Chicago, Rock Island & Pacific Railway, to succeed R. O. Carscadin, deceased.

Mr. W. H. Earle has been appointed Assistant Engineer of the Middle and Western divisions of the Atchison, Topeka & Santa Fé road, with office at Nickerson, Kansas.

Mr. Benjamin Thomas has resigned his position as General Superintendent of the New York, Lake Erie & Western Railroad. He has been on the road nearly 40 years.

Mr. Harry Wilkins has been appointed Master Car-Builder of the Natchez, Jackson & Columbus Railroad, with office at Natchez, Miss. He succeeds Griffith Enders, deceased.

Mr. Benjamin Reece has been appointed Chief Engineer of the Toledo, Ann Arbor & North Michigan Railroad. He was recently on the Lake Shore & Michigan Southern.

Mr. Yokichi Yamada, who is Professor of Mechanical Engineering in the University of Tokio, Japan, is a graduate of the Stevens Institute of Technology, of the Class of 1876.

Chief Engineer Cipriano Andrade, U. S. N., has been ordered to special duty at Cramp & Sons' shipyard in Philadelphia, in connection with the new cruisers now building there.

The divisions of the office of the Chief of Engineers, U. S. A., have been placed under the charge of Major Charles W. Raymond, Major James C. Post and Captain Thomas Turtle.

Ensigns G. W. Street and **J. W. McKay,** of the U. S. Navy, have been selected by the Secretary of the Navy to take a course of study in France to fit them to become constructors in the Navy.

Mr. Sherburne Sanborn has been appointed General Superintendent of the Chicago & Northwestern Railway. He has been for several years Assistant to Mr. C. C. Wheeler, whom he now succeeds.

Mr. George B. Whiting will, it is stated, retire on October 1 from the position of Chief Draftsman in the Bureau of Steam Engineering in the Navy Department. Mr. Whiting has held the position since 1868.

Mr. Stevenson Towle, late Chief Engineer of Sewers, Department of Public Works, New York City, will sail soon for Europe to examine the systems of drainage and sewage disposal recently constructed there.

Captain John Ericsson, the well-known engineer and inventor, was 84 years old on July 31. He lives quietly at No. 84 Beach Street, New York, still spending his time chiefly in studying and experimenting.

Mr. W. L. Cameron, who has for over fifteen years been Secretary and Superintendent of the Memphis Water Company, has resigned the position of Secretary and been appointed General Superintendent of the Company.

Mr. Rudolph Hering, Chief Engineer of the Chicago Drainage and Water Supply Commission, is to examine and report on the sewerage system of the City of New York, under direction of the Commissioner of Public Works.

Mr. John M. Whitman is appointed General Manager of the Chicago & Northwestern Railway, succeeding Mr. Marvin Hughitt, who is now President of the company. Mr. Whitman has been for several years General Superintendent of the Iowa lines of the company.

Mr. D. F. Maroney, Manager car record office of the Baltimore & Ohio, has accepted the position of Associate Editor of the *Official Railway Equipment Guide*. Mr. Maroney is one of the foremost members of the Car Accountants' Association and has done much to advance the interests of that organization. He is the author of several excellent papers read before that Association.

George L. Perkins, Treasurer of the Norwich & Worcester Railroad Company, is undoubtedly the oldest railroad officer in this country, and probably in the world. Colonel Perkins was born August 5, 1788, so that he is now over 99 years old. He was chosen a director of the Norwich & Worcester Company in 1835 and Treasurer in 1837. Notwithstanding his great age, he is still active and attends punctually to the duties of his office.

Mr. Charles C. Wheeler has resigned his position as General Superintendent of the Chicago & Northwestern Railway, and retired from that office July 31. Mr. Wheeler has served on the road as General Freight Agent, Assistant General Superintendent and his late office for a number of years. His service has not been continuous, however, as he was for a time General Freight Agent of the Michigan Central, and from 1881 to 1883 General Manager of the Atchison, Topeka & Santa Fé. He will retire from active business altogether.

Chief Engineer George W. Melville, U. S. N., has been appointed Chief of the Bureau of Steam Engineering in the Navy Department in place of Commodore George B. Loring,

relieved at his own request. Mr. Melville was born in the City of New York, January 10, 1841, and is consequently in his 47th year. He was educated partly in the Academy of the Christian Brothers and partly in the Polytechnic School of New York. At the age of 17 years he entered the East Brooklyn engine shops as a machinist apprentice. Three years later, in July, 1861, he was appointed an assistant engineer in the Navy, and was soon ordered to duty with the flying squadron, serving first in the *Dakota* and then in the *Santiago de Cuba*, under Wilkes. From this vessel he was transferred to the *Wachusett* and promoted to passed assistant. He made two cruises in the *Wachusett*, and was in her when she took the Confederate *Florida* in Bahia Roads. The following year he was employed in torpedo service. After the war, Mr. Melville served in the *Chattanooga*, the *Penobscot* and the *Lancaster*. He was then chosen an engineer of the *Tigress* in the Hall Relief Arctic Expedition, after which he made a cruise in the *Tennessee*. Mr. Melville was selected as Chief Engineer of the *Jeannette*, and his exploits in the escape of her crew from the ice pack by way of Siberia have given him undying fame in the annals of Arctic enterprise. It is not disputed that but for the endurance and the unfailing courage of Melville no part of the crew of the *Jeannette* would ever have seen home again. He was again selected for Arctic service as Chief Engineer of the *Thetis* and fleet engineer of the Greely relief squadron under Commodore Schley. Under Secretary Whitney Mr. Melville's duties have been altogether on shore, in positions requiring particular expertness as a machinist. He was first detailed to superintend the preparation of the *Atlanta's* machinery for sea. Upon the beginning of the contract work on the *Baltimore*, the 1,700-ton gunboat and the dynamite cruiser at Cramp's yard, he was ordered there as Chief Inspector of Machinery. And from that duty he has just been promoted to the highest position in his corps. Personally the new Engineer-in-Chief is devoted to his profession and possesses, besides, a wide range of scientific attainments. He is a hard worker, an indefatigable student and has shown on trying occasions executive powers of the most commanding character.

NOTES AND NEWS.

Westinghouse Brake.—The London, Brighton & South Coast Railway reports that four accidents have, during the half year, been avoided by the use of the Westinghouse automatic brake.

Brazilian Railroads.—On December 31, 1886, an official statement gave the total length of railroad in operation in Brazil at 5,805 miles. At the same time there were 3,210 miles additional located and under construction.

Kansas City Water Works.—The National Water Works Company has nearly completed the new reservoir at Quindaro, near Kansas City. As soon as it is ready for use the supply for the city will be taken from the Missouri River, instead of the Kansas or Kaw River as at present.

Brooklyn Bridge Traffic.—During the month of July the number of passengers crossing the Brooklyn Bridge was 2,215,608, an average of 71,471 per day. Of these 209,889, or less than 10 per cent., were foot passengers, while 2,005,719—an average of 64,701 per day—were carried in the cars.

Steel Ties.—The Pennsylvania Railroad Company will put down 4 short sections between Pittsburgh and New York with steel ties and with very heavy rails, secured to the ties hy chairs. Careful watch will be kept of these sections to determine the relative cost and endurance of steel and wooden ties.

Fast Tracklaying.—Shepard & Winston, of St. Paul, Minn., contractors for the Montana Extension of the St. Paul, Minneapolis & Manitoba road, claim to have done the fastest tracklaying on record. In one day (July 16) their men put down 7.2 miles; in one week 29.8 miles and in one month 103.8 miles.

Natural Gas in Kansas City.—Perhaps the most important engineering project under way in Kansas City is the utilization of the natural gas already found within a radius of 40 miles from the city. Paola, at a distance of 36 miles from Kansas City, on the line of the Kansas City, Fort Scott & Gulf Railroad, offers at present the best supply, and a company has been organized to lay a line of pipes between the cities. Work will begin very soon. Mr. Edgar B. Kay is the Chief Engineer of the company.

Navy Yard Improvements.—The Secretary of the Navy has directed that $75,000 be expended for the purchase of tools and plant for the Brooklyn Navy Yard and a like sum for the purchase of tools and plant for the Norfolk Navy Yard. This action is taken under the act for the increase of the Navy, passed at the first session of the Forty-ninth Congress, which provides for the expenditure of $150,000 under the direction of the Secretary of the Navy, for improving the plant of such navy yards as he might select.

Poughkeepsie Bridge.—The following statement of the progress of work on this bridge is published: The false-works for the shore cantilever arms on both sides of the river are up, and the erection of the steel tower on Pier No. 1 has been begun. Pier No. 2 is nearly finished, the false-works adjoining it are finished and the traveler erected ready for work. At Pier No. 3, the top of the foundation crib is prepared for the grillage, which has been hauled out and set in place; this is a solid mass of timber 100 ft. long by 46 ft. wide by 14 ft. thick. Masonry has been begun upon it. At Pier No. 4, the concrete mixers are filling in the crib pockets. Pier No. 5 has not yet reached bottom, but is going down as fast as can be expected.

Electric Railroads.—The Kansas City Electric Railroad is now in successful operation. At present the line is about a mile long only, but it is to be extended through North Kansas City shortly.

The North & East River Railroad Company in New York City has its tracks through Fulton Street nearly all down. The electric conduit is nearly completed and will be put in place as soon as the material is received from Pittsburgh.

A new electric motor, designed by Stephen D. Field, has been put on the Thirty-fourth Street Branch of the Manhattan Elevated road. This motor derives its power from a central station, the current from the dynamo being transmitted through a central rail laid on the tracks of the road.

Corrugated Iron for Coffer Dams.—In a paper before the English Institute of Engineers on the Harbor Works in Algoa Bay, Cape Colony, Africa, the author, William Shield, mentions this novel use of corrugated iron: "Corrugated sheet-iron, No. 24 B. W. G. in thickness, formed the dams for the piers and south abutment, being stayed inside with timber framing and weighted with rails, so that the dams sank into the sand and gravel as the excavation proceeded inside. The dams for the piers were about 42 ft. long, 6 ft. wide and 8 ft. high; and they were perfectly water-tight. The author thinks that this, as he believes, novel use of corrugated iron will be found satisfactory and economical where, as in the present instance, clay is expensive and difficult to obtain of good quality."

Life-Boats for the Navy.—Naval Constructor Hichborn, who spent last week in examining the life-boats on vessels in New York, returned to Washington on Tuesday. The board of which he is a member visited many vessels at New York, both American and foreign, but failed to find a boat that excels the one now used by the Navy. The greater number of boats on foreign vessels are made of wood, with air tanks fore and aft. On American vessels there are many metallic life-boats. The boat used by the Navy is a large and commodious whale-boat with air tanks. In the opinion of Mr. Hichborn it answers every need of the service, and cannot be improved upon. It now awaits models of boats being made by Dobbins, of Buffalo Hatton, of Fort Covington, N. Y., and Captain F. L. Norton —*Army and Navy Register.*

Telephones in Europe.—The *Electrical World* says: "We present some remarkable figures as to the use of the telephone in four European countries—Belgium, Holland, Italy and Russia. The tables give a list of the exchange subscribers in each country. The total of such is, allowing for a few untabulated exchanges, about 19,000. In other words, in these countries, with a total population of 136,000,000, there are only 19,000 subscribers all told, or 1 in every 7,158; while in the United States there are 147,000 subscribers in a population of 50,000,000, or 1 in every 340. The disparity is remarkable. There are as many telephone subscribers in New York and Brooklyn as in all Italy with its 28,000,000 of people; as many in Boston as in Holland with its 4,000,000; more in Chicago than in all the dominions of the Czar."

Electric Mine Railroad.—The Union Electric Company, through its electrician, Mr. W. M. Schlesinger, has made a successful electric railroad installation in the Lykens Valley, Pa., coal mines. The track is wholly within the mine and is about 6 000 ft. long. It includes a 25-ft. curve and a 30-ft. curve. The grades in most cases are slightly in favor of the load, but there are many places entirely level and long stretches of up-hill work, one grade of 1½ per cent. being reached just in front of the 25-ft. curve. The first run in was made recently. The motor met a loaded train coming out; the mules were

taken off the cars, and the motor then hauled them easily the rest of the way out—1,800 ft. Next day the train hauled out the load. The entire train weighed 112,000 lbs. The road appears to be highly thought of by practical miners.—*Electrical World*

Railroad Stations.—It is interesting to note the growing importance attached to the architecture of railroad stations. This idea is suggested by the recent news that the Fitchburg Railroad Company has accepted the plans of Hartwell & Richardson, of Boston, for a handsome depot to be erected at Waltham, Mass., at a cost of $25,000. A few years ago, railroad depots were an eyesore to passengers; they were presumably erected from orders of the engineers of the road, whose education, of course, was hardly in the line of architecture, except in its most practical sense. A new era, however, was opened when McKim, Robertson and the late H. H. Richardson were called upon to prepare designs. The West Shore Railroad had some unique and picturesque designs on its road, and the directors of railroads generally seem to appreciate the fact that utility can be combined with what is pleasant to the eye.—*Building*.

A New Armstrong Gun.—A new gun for the Royal Navy, invented and manufactured by Sir William Armstrong and Co., at Newcastle-upon-Tyne, has just been tried at the range of the company at Silloth, Cumberland. The gun is a 30-pounder, and its weight with carriage is 92 cwt. It is specially designed for the purpose of repelling torpedo attacks, and it is stated that it can be worked much quicker than the guns of the present size. The carriage is fitted with Vavasseur's patent automatic machinery, and the gun can be instantly elevated or depressed or swung round to any given point. The trial proved very successful. The gun was fired by electricity, and the velocity of the projectiles, as taken by an electric chronograph connected by wire with the muzzle of the gun, was ascertained to be 1900 ft. per second. Proof shot, common shell and shrapnel shell were used, and the firing charges contained 9 lbs. of pebble powder. The gun will shortly undergo another trial before the officials of the Admiralty at Portsmouth.

Simple versus Compound Portable Engines.—In commenting on the merit trials of portable engines at the Newcastle (England) show, *Engineering* says: "To our minds the most important lesson taught by the trials is the undoubtedly superior economy of the compound portable as compared with the non-compound engine. The compounds had, it is true, the advantage of higher steam pressures, but this was not at all sufficient to account for the extra economy, amounting to to some 28 per cent. That a non-condensing compound engine working with 150 lbs. steam can be made to work with a consumption of 1.8 lbs. of coal per brake H. P. per hour—equivalent to a consumption of about 1.55 lbs. per I. H. P.—will be regarded as little short of a revelation in many quarters, while it is a result which very few engineers would have cared to prophesy. Of course, we are not losing sight of the facts that the coal used was of very high quality and carefully selected, and that the stoking was quite exceptional in its excellence; but even allowing for these facts the performance is a most remarkable one."

Hotchkiss Guns.—The Hotchkiss Ordnance Company has made arrangements to establish a factory in the United States (probably in Connecticut), having made some heavy contracts here. In relation to this contract the Secretary of the Navy says:

"Our secondary batteries have heretofore been made abroad, and the creation of an establishment for their manufacture in this country will mark another and a most important era in the reconstruction of the navy. When Mr. Hotchkiss died in 1884, England, France, Germany, Russia Italy—every important European Power, in fact—had an establishment for the manufacture of Hotchkiss ordnance. By delaying for a time the purchase of ordnance of this character, we are enabled to tender contracts for a large supply. The company's investigations have elicited the fact that, taking the superiority of American machinery into consideration, the guns may be made as cheaply here as abroad. It was a matter of necessity with us either to set up a manufactory of our own or get the Hotchkiss Company to come here, since we can no longer afford to be dependent upon other countries for our war material. Machine guns have been an indispensable branch of naval armament.

"The six-pounder rapid-fire Hotchkiss gun requires but one man to control it, is fired from the shoulder and discharges 23 shells per minute, with a velocity sufficient for the penetration of a 2-in. steel plate 1,000 yards distant. These guns are specially serviceable against torpedo boats, unarmored ships and in clearing the exposed decks of ironclads. The company is now developing a nine-pounder and is experimenting with a thirty pounder. With the Bethlehem Iron Company contract and this one executed, American shipbuilders will be able to build and arm war-ships entirely from American manufactories."

Flanged Frame-Plates for Locomotives.—Frame-plates for railway rolling-stock have hitherto been made up of pieces of material riveted together, or the frames of wagons or carriages have been made partly of iron and partly of wood. Mr. Samson Fox, of the Leeds Forge Company, Leeds, has, however, produced, simply by hydraulic pressure, flanged frame-plates. These plates, noteworthy examples of worked steel, are fashioned at one heat by hydraulic pressure, and are provided with facing strips for the attachment of the necessary fittings. The object sought is to produce a frame-plate sufficiently rigid, transversely and longitudinally, without the necessity of angle-iron stiffeners, and, at the same time, to reduce the cost of the manufacture, and in this the Leeds Forge Company has succeeded. The flanged frame-plate is in one piece, and is more serviceable and enduring than a frame-plate built up in sections. It also possesses the recommendation of being an article which can be produced of exactly the same size a thousand times over. The frame-plates exhibited by the Leeds Forge Company at the Manchester and Newcastle exhibitions are 21 ft. 9 in. long, and are provided with three axle-box guides of the Northeastern Railway Company's standard tender-frame pattern.—*Iron.*

Blast Furnaces of the United States.—The *Iron Age* gives the condition of the blast furnaces on August 1 as follows:

	In blast.		Out of blast.	
Fuel.	Fur.	Capacity per week.	Fur.	Capacity per week.
Charcoal	67	11,533	107	8,364
Anthracite	129	37,930	68	15,058
Bituminous	113	62,091	96	41,345
Total	309	111,554	271	64,767

As compared with last year, the number of furnaces in blast and their weekly producing capacity (in tons) on August 1 was:

	1887.	1886.
Furnaces in blast	309	313
Weekly capacity	111,554	122,042

The *Iron Age* says: "During the month of July quite a number of changes have taken place in the direction of reduced current output among those using anthracite as a fuel, while there has been a resumption of work among the coke stacks, following the settlement of the strike. Quite a number of the latter had not begun blowing on August 1, which have since entered the ranks of producers, so that the current month will probably witness a gradual increase in the make. With the anthracite furnaces the decline in the make is nearly 3,000 tons a week, and we entered August with the lowest current output since the opening of the year.

Baltimore & Ohio Employes' Relief Association.—The June sheet issued by this Association shows payments of benefits to members during the month as follows:

	Number.	Amount.
Accidental deaths	9	$9,000
Accidental injuries	334	4,081
Natural deaths	6	1,500
Sickness	533	7,714
Physicians' bills	184	1,332
Total	1,066	$23,627

The Library Committee issues the following: "Through the generous assistance of the officials of the railroad company and others interested in its welfare, the Baltimore & Ohio Employés Free Circulating Library will very shortly purchase about 4,000 additional volumes of carefully selected and interesting books, which will necessitate the compilation of a new catalogue. For this purpose all Library books must be in the hands of the Librarian as soon after July 1 as possible, and those works now in circulation should immediately be returned.

"The preparation of a catalogue being a work of much labor and requiring considerable time, the Library will be closed from July 1 to September 1 and during the interval no books will be issued or access allowed to the Library room. All requisitions will be filed in order of receipt and books furnished therefrom commencing September 1. Applications for new catalogues, accompanied by the subscription price (25 cents), will be received after August 15, 1887."

A Mississippi Theory.—The Falls of Niagara are familiar to all, and came to exist through causes natural and easy of explanation, inasmuch as the whole secret lies in the character of the formations over which the river flows, viz.: a

crust made up of 60 to 100 ft. of comparatively hard limestone lying in a nearly horizontal position, beneath which is a deep deposit of shales and sandstones. Whenever the river, in wearing its channel back, reached the point where this arrangement of rocks began, the hard limestone would naturally resist the erosive action of the waters, while the underlying shales and sandstones, offering less resistance, would be rapidly cut away, until a vertical fall such as is now seen would be the result, with a constant recession going on, leaving below the broad cañon, walled on either hand by bluffs, the crests of which are preserved by the limestone crowning them.

These few reflections as to the falls and gorge of Niagara, fully demonstrated by forces now in active operation, we shall apply to the Mississippi. Here also a mighty waterway has been cut out by erosion, a fact which is universally conceded, but no definite explanation of the process has heretofore, so far as we have been able to learn, been advanced. It remained for a geology-reading inventor by the name of Robert Bates to suggest a theory which, illuminated with what little investigation we have been able to give it, promises to offer a solution of the question, or to assist in its solution. The theory briefly is, that the erosion was accomplished by means of a mighty cataract which began far down the river near its original mouth, and by gradual retrocession dug out the valley-like gorge which is so marked a feature in the upper part of its course, and left the high bluff walls on either hand, at the same time depositing heavy beds of sand at the bottom of the cañon, the product of the erosion above, and that St. Anthony Falls are the ever decreasing and receding remnants of the once most stupendous cataract the world ever saw, having a perpendicular descent of perhaps 600 ft.—*John A. Keyes, in Popular Science Monthly for August.*

Boiler Explosions in France.—We give below a summary of the bulletin published by the Ministry of Public Works in relation to accidents caused in France in 1885, by the use of steam apparatus.

The following table is a division by kind of apparatus:

	No.	Killed.	Injured.
1. Boilers with exterior furnaces:			
Horizontal, not tubular, with or without flues	8	24	21
Horizontal, tubular	2	2	..
Vertical	1	..	..
2. Boilers with interior furnaces:			
Horizontal, not tubular	1	3	7
Horizontal, tubular	1	..	..
Vertical	2	1	..
Total boilers	15	30	28
Receivers or heaters	9	4	5
Miscellaneous	1	..	..
Total	25	34	33

The total number of explosions was thus 25, by which 34 persons were killed and 33 seriously hurt; slight injuries are not included.

A division according to the supposed causes of accident is as follows:

Defective construction, material or placing	5
Fatigue, weakening or corrosion of metal	7
Repairs neglected or badly made	2
Low water	6
Too high pressure	4
Other cases of neglect or imprudence	6
Miscellaneous	2

It will be seen that the total number of supposed causes is greater than that of accidents. This is due to the fact that in several cases an accident was attributed to two or three different causes working together.—*Portefeuille Economique des Machines.*

Copper Mines in Japan.—A report recently made to the British Foreign Office on the Ashiwo copper mines in Japan says that the work is conducted under the general management of an engineer from the Imperial College of Engineering in Tokio, and over 4,000 miners are constantly employed. In addition to the reduction works and sulphate of copper factory, there is a complete shop for repairing all machinery, and all the different branches are connected by telephone. Owing to the expense connected with the transport of ore from an isolated working, a tunnel is being bored to connect it with the main lodes, the length of which will be 11,880 ft. In connection with this, a steam rock drill of 10 H. P. was started last year and is working satisfactorily. At present two Shrenne rock drills are being used in driving this heading, and four others are on their way from Germany. Dynamite is used for blasting, and the shots are fired by electricity. The present plant in the reduction works consists of 2 crushing rolls, 8 stamping mills of five heads each, 42 jiggers, 8 percussion tables, 9 sieves and 3 steam engines of a total of 68 H. P. Hitherto the machinery employed has been procured from England, France and Germany; but, as a German metallurgist has recently been engaged, it is more than probable that, in accordance with a general custom, all orders will in future go exclusively to Germany.

Railroads in Sweden.—A note in the *Annales de Ponts et Chaussees* says that what characterizes the establishment of railroads in Sweden is not only the cheapness with which they have generally been built and operated, but also the variety of gauges adopted. Nowhere else, except perhaps in Norway, has there been tried on so large a scale the experiment of the narrow-gauge, varying from 4 ft. to 28¼ in.

The length of completed line is divided among the different gauges as follows:

Guage.	Mileage.
4 ft. 8½ in., Standard Gauge, 39 lines in all	1,758
4 ft., 4 lines	1,030
3 ft. 8 in., 1 line	57
3 ft. 7 in., 2 lines	30
3 ft. 6 in., 4 lines	137
2 ft. 11 in., 18 lines	435
2 ft. 7½ in., 2 lines	64

The lines under construction or projected are to have the following gauges:

Gauge.	Mileage.
4 ft. 8½ in.; 14 lines	543
3 ft. 3⅜ in., (1 metre), 1 line	117
2 ft. 11 in., 7 lines	10
2 ft. 4¼ in., 1 line	3

There are thus in Sweden eight types of narrow gauge, but that which tends to increase the most is the 2 ft. 11 in. gauge, which will soon have a total length of 552 miles, or over 60 per cent. of the narrow-gauge mileage.

On the roads of standard gauge the minimum radius of curvature is generally 975 ft.; on some of the lines, however, this is reduced, notably on the Banghammar line, near Kloten, where the minimum radius is 684 ft. On the narrow-gauge lines the minimum radius of curvature is 487 ft. Swedish practice follows the English rather than the American as to curvature, as well as in other points.

The cost of the standard-gauge lines has varied from $14,800 to $50,500 per mile; that of the narrow-gauge lines from $8,100 to $33,250 per mile. The roads generally have been cheaply built.

Loss of Heat from Steam Pipes.—The *Locomotive* reports as follows some practical tests to ascertain the loss of heat from uncovered steam-pipes and those covered with different coverings, made by Superintendent Upson and Chief Engineer Steele, of the Hartford Carpet Company:

"A room having a very even temperature and free from draughts or air currents was selected, close to the boilers, where steam could be taken from the top of the main pipe, and free from water of condensation. A suitable vessel was arranged to collect the water of condensation, and connected to 120 running feet of 2-in. steam pipe. A short section of the pipe was enclosed in a suitable box with a glass in the side for the purpose of reading the rise of temperature, as indicated by a thermometer placed therein.

"Steam was first blown through the pipe and receiver until both were free from the water of condensation which was caused by heating the pipe and receiver. The valve was then closed, and 10-hour trials made, the water carefully collected and weighed, with the following results:

"1. The first trial was with 120 ft. of 2-in. pipe, uncovered, results as below:

Average steam pressure	79 lbs.
Average temperature of room	70 deg
Average temperature of box	167 "
Water condensed	862 lbs.

"2. The second trial was with 120 ft. of 2-in. pipe, covered with asbestos, hair-felt and paper, results as below:

Average steam pressure	77 lbs.
Average temperature of room	69 deg.
Average temperature of box	80 "
Water condensed	222 lbs.

"3. The third trial was with 120 ft. of 2-in. pipe, covered with plastic material, results as below:

Average steam pressure	80 lbs.
Average temperature of room	70 deg
Average temperature of box	107 "
Water condensed	480 lbs.

"It will be seen from the above that the loss by radiation greatly exceeds that usually estimated for uncovered pipes, but it agrees very well with trials made upon machines carrying high steam pressures. The saving by covering the pipes is very satisfactory, and in the second trial the temperature in the enclosed box was but little higher than that of the room."

A Gas Accident.—The London *Engineering* says: "As a timely reminder to those whose business it is to look after the safety of railway travelers, it will not be out of place to mention the painful accident which has just occurred on the Berlin-Potsdam Railway, the third fatal one, it may be noted in passing, which has taken place on the line in recent times. It appears that an empty goods train was prematurely signaled

into the station at Waansee, and ran into a standing excursion train waiting to return to Berlin, when a smash took place which caused the reservoir of gas under one carriage to explode while the locomotive of the goods train caused the gas to ignite, which flew about in all directions and over the cushions, and set fire to everything inside the carriage in which three persons were caged, and could neither escape nor receive assistance from without on account of the build of the carriage, and were in the most incredibly short space of time burnt to an actual cinder. The only remnant of the male passenger appears to to have been part of his waistband by the buttons of which it is hoped to recognize his personality. The obvious moral to be drawn from this sad catastrophe is, that where gas is used on railroads the reservoir of it must be so placed and formed that under no circumstances, can it be smashed by a collision or the gas ignited if such should take place. The gas receiver in this case was a long sheet-iron drum, placed transversely beneath a second-class carriage."

Russian Railroads in the Caucasus.—Two important events have occurred in connection with Russian railroads in the Caucasus. The Novorossisk tunnel, which has been 15 months in hand, has been successfully pierced, and there is every prospect, therefore, that the line from St. Petersburg to this Black Sea port (Batoum), will be completed by the time stipulated this spring. The tunnel is 4,500 ft. long, and had to be excavated through the solid rock. Owing to the strategical importance of the line the Government has been pressing on the work at any cost. When complete, it will be possible to send troops from any part of Russia to this Cis-Caucasian port, and not only prevent invasive operations on the coast in the event of a war with England, but provide a means of sending troops against Turkey from a new quarter in the event of Russia being able to block the Bosphorus and control the Black Sea. Regarding the commercial importance of the line it traverses the Black Sea petroleum region, and thereby lays it open to European enterprise.

The second event of importance is the decision of the Russian Government to provide a credit for 3¼ million roubles, to be expended in adding 18 locomotives and 1,296 freight cars to the rolling stock of the Transcaucasian Railroad. This remarkable addition demonstrates the rapid growth of traffic on this road, which has been so great that camels were for a time requisitioned to convey goods from the Caspian to Tiflis, alongside the line, to ease the excessive traffic. It is popularly supposed that the bulk of the traffic on this railroad consists of petroleum, whereas last year this only composed a third of the general total. The fact of the matter is that the opening of the 700 miles of line from Krasnovodsk to the Oxus, on the Central Asian side of the Caspian, has tapped the large trade with Russia existing *via* Orenburg, and has attracted it to Baku and Batoum. The whole of the 1,296 cars and 18 locomotives are to be made in Russia and sent to Transcaucasia with as little delay as possible. In the meantime fresh arrivals of petroleum tank cars are reported, the refiners at Baku readily availing themselves of the newly accorded privilege to run their own oil cars on the line. The firm of Nobel is introducing 600 or 700 of them, each conveying 10 tons of petroleum.

Transmitting Power by Electricity.—A plan has been proposed for transmitting power by electricity to the City of Valencia in Spain, which is a manufacturing town of importance. The power is to be obtained from the River Turia, about 35 miles from the city, at a point where the stream describes roughly a semi-circular arc. Along a chord of this arc, measuring 1.37 miles in length, it is proposed to cut a canal, at an almost horizontal level, thus obtaining at the outlet a fall of 108 ft. to the bed of the river. The line of the canal is, however, intersected by a range of rugged hills, under which it will be necessary to tunnel for a distance of rather more than one mile. The intake will be effected at a point where the river issues from a deep and narrow ravine (the Pass of Cingdos), and this configuration offers peculiar advantages for impounding the flow and constructing the necessary dam and sluices. At the farther end of the canal the ground is favorable for the construction of a reservoir upon the higher level, and for the erection of the machine-house upon the river bank.

The mean annual volume of water to be dealt with is stated, after numerous experiments, to amount to 353 cubic ft. per second, which, under a head of 108 ft. will be found to account for 4,200 horse-power (theoretical). It is proposed to utilize this force by means of Jonval turbines, for which an efficiency of 70 per cent is assumed, thus yielding a brake horse-power of 2,940, or, say, 3,000.

This 3,000 H. P. will be transmitted to Valencia by electricity, and the projectors have calculated a large return on the investment required. The cost of the dam and other works is estimated at about $665,000. The details of the method of transmission have not been fully worked out.

Phosphor-Bronze Wire for Helical Springs.—At a recent meeting of the Engineers' Club of Philadelphia, a note by Mr. Wilfred Lewis on Phospho-Bronze Wire for Helical Springs was presented as follows:

"About a year ago, in designing valves for hydraulic machinery, it became necessary to use springs in the water ways, and to guard against corrosion, it was suggested that they be made of phosphor-bronze.

"No information, however, could be found for determining the proper size of wire and its probable extension or compression, and accordingly the writer undertook to make the following partial solution of the problem. A piece of wire No. 12 diameter and several feet long was obtained from our fellow member, Mr. Lüders, for the special purpose mentioned, and coiled in the form of a spiral spring 1¼ in. in diameter, from center to center, making 52 coils.

"This spring was loaded gradually up to a tension of 30 lbs., but, as the load was removed, it became very evident that a permanent set had taken place. According to formulæ recommended by D. R. Clark for helical steel springs, such a spring of steel should bear with safety a load of 20 lbs., while, according to the practice of the Pennsylvania Railroad, it might be used for double this load, or 40 lbs.

"A weight of 21 lbs. was then suspended from the bronze spring, so as to allow a small amount of vibration, and the length measured from day to day.

"In 30 hours the spring lengthened from 20⅝ in. to 21⅛ in., and when suspended 200 hours, its length was found to be 21¼ in.

"It was concluded from this that 21 lbs. was too great for durability, and that probably 10 lbs. was as much as could be depended upon with safety.

"For a given load it was found that the extension of the bronze spring would be just double the extension of a single steel spring; that is, for the same extension, the steel spring is twice as long.

"The above experiment is not very conclusive, but my practice now is to allow for phosphor-bronze springs the same extension or compression as for similar steel springs, and let them carry one-half as much load."

Effects of Explosives.—At a recent meeting of the Royal Society of Edinburgh, Professor Tait made some interesting and suggestive remarks on the effects of explosives—a subject having some connection with lightning flashes. The singular fact had been stated in the newspapers that an explosion of dynamite in the Underground Railway in London produced the excessively curious effect that several persons within a certain range had the drum of one ear ruptured, while no effect was produced on the drum of the other ear. If he had not been thinking for years about the effect of lightning flashes upon the air, he must have set down this to newspaper reporting. The difference between the effect of a sudden explosion in the immediate neighborhood of the center at which the explosion took place, and the effects of the same at a moderate distance, might be perfectly different from one another; and when examination was made of the matter from the physical point of view it was found that the difference depended on this: that as long as the projectile matter—whether it was the air itself around the explosive, or the materials of the explosive which were driving it from the center of explosion—were going at a velocity greater than sound, the effect of their motion was precisely the same sort of thing as is observable in the case of a falling star. It compressed and immensely heated the air immediately in front. So long as it exceeded the velocity of sound, there could be no vibration propagated beyond the limit to which the explosion had extended, and the gases only came, as it were, into contact with a dead stone wall of stationary air outside. The result was that the air was compressed and became self-luminous by the instantaneous compression. So it was with lightning. Up to the point at which the velocity became that of sound there would be an exceedingly intense impulsive pressure, and there was great danger of very considerable damage. The question of how much force was required to rupture the drum of the ear was a question for physiologists. Being asked by Dr. Wallace how it was that, for explosive purposes, gunpowder required to be inserted into the material to be exploded, while dynamite was placed on the top, Professor Tait replied that dynamite exploded with great rapidity, and the consequence was that the gases expanded with exceeding rapidity, whereas gunpowder was burnt comparatively slowly, and produced the effects of increased pres-

sure with graduated speed. If the velocity was much greater than that of sound there was percussion, otherwise there was nothing but the propagation of vibration. It was the difference between a wave and a breaker.

The Latrobe Corn-Stalk Columns.—In the vestibule of the Capitol at Washington, beneath the office of the Marshal of the Supreme Court, are the only truly American columns in existence. If the student of architecture regrets that this country has not produced any architectural effort of its own, he should be referred to this work of Benjamin Henry Latrobe, who succeeded Messrs. Hallett, Hadfield & Hoban as the Capitol Architect and perfected the designs of Dr. Thornton. In a letter of Latrobe's to Thomas Jefferson he refers as follows to his designs: "I have packed up and sent to Richmond, to be forwarded to Monticello, a box containing the model of the columns to be used for the lower vestibule of the senatorial department of the north wing of the Capitol, which is composed of ears of maize. * * * These capitals, during the summer session, obtained me more applause from the members of Congress than all the works of magnitude or difficulty that surround them. They christened them 'corn-cob capitals;' whether for the sake of alliteration I cannot tell, but certainly not very appropriately."

This letter was addressed to Mr. Jefferson, and bears the date of August 28, 1809. Latrobe, not Jefferson, was the designer of the pillars. Many considered the latter to be their parent, because he teok such an interest in the erection of the Capitol, and is known to have proposed many changes to the architect. Jefferson spoke to Latrobe of the lack of individuality in our public buildings, and asked why he did not conventionalize some of our native vegetation into appropriate columnar designs. Doubtless acting on this, Latrobe produced the corn-stalk columns which now stand in a somewhat unnoticed portion of the Capitol. Each column is composed of a cluster of Indian corn-stalks bound together so that the joints of one stalk stand slightly above the preceding one; thus, by the recurrence of the joints in the seven divisions of every stalk, a spiral effect is produced. The capitals are composed of ears of maize with the half-open husks displaying the corn, which in its upright position has been criticised as being too stiff.

Whatever the faults of the original pillars may be, they are a bold stride toward forming for ourselves an ornamentation peculiarly in keeping with our new and vigorous Government. That our buildings have to be supported by Doric, Ionic and Corinthian columns, unrelieved by anything of our own conception, is strange, when we consider the independence of the people of the United States. We have given to the Old World our mechanical inventions, the benefits of scientific research, yet we borrow from the East all our architectural forms.—*Eugene Ashton, in the Magazine of American History for August.*

The Wagner Free Institute of Science.—This Institute was founded by the late William Wagner, a citizen of Philadelphia, who devoted a long lifetime to the study and advancement of the sciences, especially the different branches of natural history. Mr. Wagner, during his life, formed a large museum, a library, and a collection of chemical and physical apparatus. He established annual courses of lectures on various scientific subjects, in which he personally took an active part, which were continued for thirty years, and which were always open free to the public. In 1855, under the above name, the institute was incorporated by an act of the Legislature.

Mr. Wagner bequeathed his property to the Institute, vested in a board of trustees. Since his death in January, 1885, the trustees have been actively engaged in carrying out his plans, and in accordance with his views, have elected a faculty of four professors to take charge of the museum and library, to give lectures free to the public, and to teach the method of, and also to make, research. The first annual course of free lectures was given by the faculty during the season of 1885 and 1886. The sphere of usefulness of the Institute will expand as the pecuniary circumstances are adjusted and will permit. That the benefits of the Institute shall not be restricted to its locality, but may be widespread as possible, the trustees propose to make provision in aid of original research and the publication of its results, towards the increase and diffusion of knowledge among men.

Mr. Joseph Wilcox, one of the trustees, who had spent several successive winters in Florida, in speaking of his observations in that State, suggested the interest it would be to the Institute and to Science to make an expedition to certain portions of the country, to make collections and investigations in their geology and fauna. Liberally offering his pecuniary and personal aid, and encouraged by the Academy of Natural Sciences, the trustees of the Institute made the necessary provision, and last winter sent Prof. Heilprin on the proposed expedition in company with Mr. Wilcox. The results were valuable collections in zoology, and especially in geology, together with important investigations and discoveries in the latter, an account of which is presented in the report by Professor Heilprin, which has just been published as Volume I of the *Transactions* of the Institute. The well observed facts of the report must greatly modify the opinions which have been generally held in regard to the geological construction of the peninsula of Florida; and altogether Prof. Heilprin's researches must be considered as an important contribution to Science.

An English Electric Car.—A tramcar of the Jarman pattern, carrying 46 passengers, was recently tried at Brixton. The electric motor is placed under the tramcar between the axles, and the storage battery is distributed under the seats of the car. In Mr. Jarman's motor excessive heating is prevented by means of two armatures, which are fitted on one axle. One of these armatures drives the car in one direction and the other propels it in the contrary direction, so that each armature has time to cool down should it become heated on a journey. The storage battery consists of 70 E. P. S. cells, the contents being 195 ampère hours, or equal to a run of about 20 miles. The cells are charged in the usual way by a stationary dynamo at the depot, as may be found necessary. The weight of the car with its electro-motor and storage battery complete is about 5 tons 6 cwt., the car itself weighing 3 tons. It is driven from either end and is fitted with a very effective friction brake, which grips the axle of the motor. The car is lighted by electricity, and is fitted at each end with a brush for clearing obstructions off the rails. The experimental runs made with this tramcar were very satisfactory, so far as the shortness of the line would permit. The line is laid with a sharp curve of 43 ft. radius, which was easily traversed, and an incline of 1 in 40, which was readily mounted, and on running down which some good stops were made. In running upon the level at a fair speed the car was pulled up dead in half its length and showed itself to be well under the control of the driver. It had on a previous occasion made a trial run, loaded with 52 passengers, from Brixton to Westminister Bridge and back, with what are stated to have been very satisfactory results, a high rate of speed being attained and the car being run from the tramway to the works at the finish over the macadamized road without detriment.—*London Times.*

Engineering in Palestine.—In a review of Mr. Oliphant's book "Haifa; or Life in Modern Palestine," the London *Times* says: "The author makes mention of two grand engineering projects, one of them plausible and practicable, the other very much in the air. The first is the Great Palestine Railway, which has been surveyed from Haifa as far as the Jordan. The concession is held by a knot of gentlemen, some of them Moslems, others Christians, but all subjects of the Porte. His opinion is that it is 'a real, *bona fide* enterprise, and one which is likely to become a large source of profit, * * * for it will tap one of the richest grain-producing districts of the East.' The surveyors see no serious engineering difficulties. It crosses the Kishon by a 60-ft. bridge, it runs smoothly over the wide plains of Esdraelon, and there will be a station, or rather a junction, for Nazareth. The Jordan Valley Canal is a more ambitious scheme, nor do the estimates appear to be so absolutely reliable as to tempt the cautious investor. Optimists set them down at £8,000,000 sterling, while unfriendly pessimists carry them so high as £225,000,000. 'The whole length of the canal would be 250 miles, of which, however, only about 120 would be actual cutting, but cutting of a nature unparalleled in the history of engineering.' The idea is to flood deep depressions of the Jordan Valley with the waters of the Mediterranean and to connect the Dead Sea with the head of the Red Sea at Akaba. It is hardly necessary to speculate on the probable traffic, for, setting financial hitches aside, the sentimental and political difficulties would seem to be insurmountable. The canal would swamp the Lake of Tiberius, and sink the scenes of the Savior's Galilean ministration 500 ft. beneath sea level. By making English influence predominant in Palestine it would provoke the opposition of France and Russia; and if it should really prove an engineering success it would ruin the Suez Canal and the shareholders. As for the Sultan, he might possibly be tempted by the sums of ready money which he would receive in exchange for submerged territory. But, on the other hand, he would have to resign himself to part with another province, since Palestine would be virtually annexed by the English. Jericho would be submerged with other places, and that would be a pity, for, according to Mr. Oliphant, there is a fair prospect of the 'City of palm trees' rising into reputation as a winter watering place. Aristocratic Russian pilgrims bound to bathe in the Jordan

have taken it under their patronage; very comfortable quarters are already to be found in a large building erected for their special accommodation; and for those who prefer a quieter and more domestic life clusters of neat little cottages *ornées* have been run up. Jericho may be dull, but it has its recommendations. 'There is a peculiar softness and balminess in the air not to be found elsewhere in the world, for there is no other place in the world 1,100 ft. below the sea line.' For the friends of the invalid there is good galloping ground on the plains and wild shooting in the thickets between Jericho and the 'swellings of the Jordan,' and the Ottoman authorities appear to believe in the future of the place, for they are actually bestirring themselves over improvements and reclamations in the neighborhood."

The Nordenfelt Torpedo Boat.—A trial of the *Nordenfelt* submarine boat built for the Turkish Government was recently given before the Sultan at Constantinople, and is thus described by a correspondent of the London *Times*: "The order to leave her moorings reached the *Nordenfelt* at 2 p. m. The boat was lying at the time under banked fires, and within 20 minutes she was under way, proceeding down the Golden Horn at a rapid rate, piloted by two steam launches. She showed her remarkable steering qualities by the manner in which she threaded her way among the numerous lighters and smaller craft that would hold their course in spite of warning whistles and shouting. As she shot the bridge, no easy task in a long craft with a current setting across the opening, a loud murmur of surprise and admiration arose from the crowd of spectators attracted by the desire to see the wonderful boat which, according to rumor, can travel as well under the sea as on the top of it. The boat at the time was in her surface condition—that is, with her funnel up, so as to keep in play the furnaces of the ordinary boiler, and more or less of the hull showing for its full length. Painted as she is of a light gray color, even in this condition, however, it was no easy matter to see her at any great distance, as there was no smoke issuing from the funnel to attract the eye. Arriving off Seraglio Point, the boat stopped, awaiting the orders of the Sultan, who had notified his intention of personally directing the manœuvres. Here, in the very worst part of the current, she easily maintained her position with a few turns of the screw, while her attendant launches were obliged to seek the shore. The order having been given to attack, as a surface boat, a merchant steamer lying off the Scutari shore, the *Nordenfelt* rushed ahead at full speed. End-on, the target she presented was remarkably small, only a dome with a bit of chimney on it; while broadside-on, the difficulty of seeing her was increased by the bow wave. She seemed to cut her way like a plough, banking up the water on each side as it rolled over the snout—to hide herself, as it were, in the furrow between. Suddenly two thin jets of water were seen to rise from the bows, to fall again in showers of spray. This was due to the opening of the torpedo tube-door, and in action would have marked the dispatch of her formidable weapon. As the said door is opened, the water rushing in, drives out the air with the effect just mentioned, which, to uninitiated eyes, would bring confirmation of a previous idea that a whale was in sight; from its resemblance to the action of one of those animals spouting. After this attack, a trial was made of speed against the current. The *Nordenfelt* proceeded very steadily ahead, doing her 8 knots over the ground easily against the full strength of the Bosphorus current, which proved her to possess a speed of something over 12 knots—a very satisfactory result, considering that she was only designed to steam 10. On her return to Seraglio Point, the Sultan desired that a second attack should be made upon the steamer previously mentioned. The funnel having been lowered, the *Nordenfelt* proceeded ahead, gradually sinking as the ballast tank was filled to reduce the buoyancy. On reaching the steamer she was suddenly lost to view, but shortly afterwards came steaming round from the other side. She was supposed to have launched her weapon under water, and then, changing course, risen in another direction in order to facilitate escape in case of a mine. His Imperial Majesty expressed his great satisfaction with the performance of the boat after this run and then ordered her to return to the dockyard.

"Before concluding, it is as well to point out that, although the boat was lying under banked fires, the reserve steam was quite ready, the water in the reservoir having been heated up to the necessary degree over night. This is the normal condition in which these boats would be kept in time of war. They can be maintained in this condition of readiness for days together at a very small expense. The loss of heat from radiation is so small, owing to the special arrangements about the boilers and reservoir, that the pressure in 24 hours only falls some 101 lbs., and this is easily regained by the consumption of from 200 to 300 lbs. of fuel. The boat was altogether under way about five hours, during two of which she was manœuvring solely with reserved steam. At the end of the performance 700 lbs of pressure was still left."

Sodium and Aluminium.—The London *Times* describes a recent metallurgical improvement just brought to a successful commercial completion at experimental works erected for that purpose in that city. This is a new process for the production of sodium, and through sodium, of aluminium and magnesium, which are dependent upon it. The process is the invention of Mr. H. Y. Castner, of New York, who has been engaged on it for several years, and who had obtained certain remarkable results in his laboratory there previous to his coming to England, in order to develop the process on a larger and more perfect scale. The effect of the new process will be to place a practically unlimited supply of sodium, aluminium and magnesium, as well as of metallic alloys dependent upon these substances, at the disposal of the various arts and manufactures at one-fourth of the cost at which they have heretofore been available, and thus to greatly cheapen the many articles of commerce and every day use into which they largely enter.

In the process hitherto employed for the manufacture of sodium and potassium, carbonate of soda, charcoal, and lime, in the proportions of 30, 13, and 7, are finally mixed and calcined at a red heat. The compound mixture is afterwards introduced into wrought-iron cylinders and heated to 1,400° centigrade. The alkaline metal is thereby reduced and distilled from the cylinder containing the charge through a small tube provided for the gases and vapors into a condenser. But the quantity of metal recovered by the process is not usually more than 40 per cent. of that contained in the charge, while the wear and tear on the metal cylinders and furnaces employed is estimated as equal to about 25 cents per pound of sodium produced. In the Castner process the operations are carried on in large cast-steel crucibles. The charges consist of caustic soda and a finely ground artificial compound of carbon and iron, which is the reducing agent. The crucibles are first heated in a small furnace at a low temperature, in order to expel the hydrogen from the caustic alkali, and fuse quietly. They are afterwards removed to a larger furnace, where the sodium is reduced at a temperature of 850° centigrade, whereas the old temperature was not less than 1,400° centigrade. While reduction is in progress the vapors and gases pass from the fused mixture through the exit pipe from the cover into the condenser, where the metallic vapors are condensed to metal while the uncondensed gases escape by a small outlet tube. It is a remarkable fact that about 75 tons of fuel have been required hitherto to produce one ton of sodium, whereas by the Castner process not more than 25 tons are required for the same result. The chief item of saving, however, is that of the wear and tear of cylinders and furnaces. The steel crucibles used in Mr. Castner's process show but little wear and tear. It has been calculated by chemical experts that a crucible will stand at least 200 operations, which would represent not more than 2 cents per pound of sodium produced. The wear and tear of furnaces is calculated at 2 cents more, giving for these two items about one-twelfth the expenditure hitherto required. The furnace already at work is capable of producing 120 lbs. of sodium per day, or at the rate of about 16 tons per working year. This is believed to be a larger quantity than any works now in existence are capable of producing. The materials employed in the process are inexpensive. Eight cents' worth of caustic soda is equal to the production of one pound of sodium. The actual cost of production is not more than 18 cents per lb., which will allow of the substance being sold at 25 cents per lb., or $500 per ton.

The Castner process promises to open up large and important fields of usefulness for the expensive and hitherto comparatively little used substances that have sodium as their base. The principal of these is aluminium, which is impervious to the action of the atmosphere, is not affected by acids, and is better adapted than any other material for many artistic and useful purposes, including not only personal decoration, but submarine work, torpedoes, etc. The use of small quantities of aluminium is found to produce remarkable effects on iron and steel. The application of that metal is said to be the distinguishing characteristic of merit of the Mitis castings introduced by Mr. T. Nordenfelt, and alike to iron and to other metals it imparts the essential quantities of tensile strength, luster, and a capacity for resisting oxidation. Many authorities believe on this account that aluminium alloys with steel or copper will provide the highest qualities of metal for ordnance purposes. Cheap sodium, moreover, facilitates the production of chromium, which imparts valuable properties to iron and steel, and the use of which in iron and steel manufacture appears to be limited only by its available extent.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid............$3 00
Subscription, per annum, Foreign Countries......... 3 50
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery Avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, OCTOBER, 1887.

THE dynamite gun, in which a shell containing dynamite or other high explosives is used, and in which compressed air is the projecting power, has apparently established its place as an efficient and formidable weapon for coast defense, if not for an aggressive attack. A range of some two miles has already been attained, and it is not improbable that this can be improved, while the projectile is capable of doing very much greater damage than that thrown by an ordinary gun of many times the weight of the dynamite gun.

The dynamite shell is practically an air-torpedo, with the advantage that its course can be regulated and directed with a much nearer approach to certainty, and with much simpler machinery, than that of the submarine torpedo, while its effective range seems to be much greater.

WHILE the work of preparing the Navy for war is going on, and new battle ships and cruisers are planned and built, the duties which frequently devolve on the service in time of peace should not be forgotten. To watch and protect commerce is, of course, the chief work of the Navy usually, and to enable it to do this efficiently there is needed—in Chinese and other Eastern waters, in Alaska, and for the squadron in the Southern Pacific especially—a class of small gunboats or dispatch boats to serve with the large cruisers. The service which these boats should perform is now devolved on a few tugs and old steamers, some of them almost unseaworthy and all poorly equipped and supplied with machinery of obsolete patterns. The work which they do is poorly done and at an unnecessarily great expense.

The vessels that are really needed are of small size and light armament, with engines of the latest and most economical patterns, and arranged to carry fuel for a cruise of considerable length. They would not be costly to build or arm, and would fully pay for themselves in a short time in the saving over the cost of running the ships now in use.

FROM the tables prepared for the English "Lloyd's," which probably approach completeness more nearly than anything else attainable, it appears that at the beginning of the present year the mercantile shipping of the world included 35,124 vessels, having a total registered tonnage of 20,943,650. Of these 9,969, of 10,531,843 tons, were steamers, and 25,155, of 10,411,807 tons, were sailing vessels; the steamers thus averaging nearly 1,100 tons each, while the sailing vessels averaged only about 400 tons.

An illustration of the modern tendency is found in the fact that while there was last year a small increase in steam tonnage, there was a decrease both in the number and tonnage of sailing ships.

The figures given, it must be remembered, include only sea-going ships, no vessels of less than 100 tons burden and no boats engaged in river or other purely inland navigation being included in the list.

Great Britain heads the list of shipowning countries, being credited with about 65 per cent. of the steam tonnage and 38 per cent. of the sail tonnage. The United States, while fourth in the list of steamship owners, having only about 8 per cent. of the steam tonnage, is given as second in sailing tonnage, having about 15 per cent. of the total of that class.

While over 96 per cent. of the steam vessels are reported as built of iron or steel, wood still holds an important place among the sailing vessels, about 80 per cent. of the tonnage (92 per cent. of the number of vessels) being of that material.

JUST at present a falling-off in the demand for steel rails and other supplies for new railroads is reported, although all the rail-mills and other works are very busy on orders which will require some months yet to fill. Those who watch the markets closely, also report that new railroad securities are now not taken up at all by investors.

As has been heretofore noted, the building of new railroad lines this year will probably reach nearly, if not quite, 12,000 miles. The construction of so great a mileage requires the investment of an enormous sum of money, and a large part of the surplus capital available for such purposes has probably been already invested, and its owners are inclined to wait and see the result before putting in more. Then, again, the immediate demands of traffic will be pretty well satisfied by the new lines now under construction, and there is not much disposition among the investing public to put their money into purely speculative railroads, in view of the events of the past few years.

There are quite enough of these speculative railroads building as it it, and a condition of affairs which will prevent the undertaking of more is not an unmixed evil. The speculative road is usually not only a waste of money in itself, but it is also a hindrance to legitimate enterprises which would really benefit the country.

THE Canadian Government has decided to send no more expeditions to Hudson's Bay in connection with the projected opening of a route to the Northwest. The Govern-

ment has come to the conclusion that the navigation of the bay is too uncertain, and the season too short to warrant the building of a costly railroad line to reach its waters. From present information it appears that the longest period of open navigation to the ports on Hudson's Bay is three months in a favorable season, while there is often less than two months of open water; moreover, masters of vessels do not like the voyage, as fogs are very common in the summer, and they always run the risk of being caught in the ice and compelled to winter in the bay. Under these circumstances this line could hardly be deemed a reliable one as an outlet for any considerable traffic, or, indeed, for any traffic which could find another route. Seen on the map the Hudson's Bay route from Manitoba looks like a direct and excellent one, but it is, unfortunately, too far north to be available for practical use.

The railroad from Manitoba to York Factory, or such other point on the bay as might be chosen, would be probably blocked by snow the greater part of the year. Its business would be almost entirely dependent on the navigation, for no local traffic could be hoped for beyond a few miles from Winnipeg. As the Government has practically, by its recent decision, put an end to all hopes of subsidy, the building of the road might as well be abandoned, and probably will be given up, although the talk about it may be kept up for a little while longer.

THE sixth convention of the American Street Railway Association, which will be held in Philadelphia, October 19, will be a meeting of unusual interest, owing to the important topics to be discussed. Ever since the Association was formed, the question of a substitute for animal power has been before it, but at no previous meeting has there been so much actual progress to be reported. The cable railroad has for some time been regarded as a success where an expensive plant is warranted by the traffic, and the experience now gained is sufficient to show that the electric railroad must be considered in all plans for the future. These and other questions will give the Association abundant material for discussion.

THE New England Railroad Club at Boston and the Western Railway Club at Chicago have opened their respective seasons in a manner which promises well, and a series of interesting meetings may be looked for through the winter. The Master Car-Builders' Club in New York has not, as this is written, yet completed its arrangements for meetings, but will doubtless do so before long.

SOME reference was made in this column last month to a plan for using electricity to increase the adhesion of locomotive drivers to the rails which was tried on the Central Railroad of New Jersey nearly 30 years ago. As then stated, no official record of the test seems to have been preserved in the offices of the company. Some of those who took part in them, however, are still on the road, and their testimony is that the trials were continued for some time on two or three engines, but with little or no success, and were finally given up with the conviction that the results obtained were not sufficient to warrant further use of the apparatus.

The arrangement used was a battery (or batteries) carried on the running-board of the locomotive, from which connections were made to the tires by means of a magnetic coil. No very definite description of the apparatus survives, however. It was the work of a French inventor named Quetil, we believe.

These experiments, however, were really of very little importance, and are only of interest as showing how present investigations were anticipated at an earlier day, when less was known about the subject of electricity than now.

THE derailment of a train by wind is not a kind of accident altogether unprecedented in this country. In the West and Southwest, such accidents occur nearly every year, the cyclones of those sections of the country sometimes upsetting trains with disastrous results. Similar accidents have also occurred among the mountain gorges of Colorado. An English contemporary mentions a wind derailment on the Southwestern Railroad of Russia, in which 18 freight cars were wrecked, as something almost if not altogether new. In the Russian case, the train was not on a steppe or prairie, but on a hillside, the wind being concentrated in force by sweeping through a long and narrow valley, corresponding thus to the mountain accidents in Colorado.

THE INCREASE OF THE AMERICAN NAVY.

THE people of the United States have, ever since the adoption of their constitution, been congratulating themselves—and with good reason too—that they are not obliged to maintain a large standing army and a costly navy. There is too much business shrewdness in the American character not to see the immense advantage we have enjoyed in being relieved of the obligation of constructing and maintaining a great army and navy. The money expended on these, in more senses than one, would be dead capital, and unproductive of the utilities of life and happiness. Our own civil war, however, suggested the possibility of foreign invasion, which it has often been feared might be invited by our defenseless condition. This fact and an overflowing treasury have created a very general and strong sentiment in favor of an increase of our navy and sea-coast defenses.

A great deal has been said of late years, too, of the need and the wisdom of the National Government granting aid, in the form of bounties or otherwise, to our foreign shipping. Attention has often been called to the fact that the British and other governments, by subventions of various kinds, help to sustain the great lines of steamers which maintain their commercial relations with all parts of the world, and hardly a session of Congress passes without some schemes being presented for the encouragement of foreign shipping or maintaining the National flag with "an appropiation."

During the last few years, large sums have been appropriated for the building of warships and the creation of a navy, and it now seems as though we are about to follow the example of European nations, in a policy which to them has been so costly and generally profitless.

Looking at the question from an economic point of view, it would seem as though it will be a great waste of money to build and maintain a large number of ships, which in time of peace will be useless, and then duplicate the expenditure for other ships to be employed in beneficial commerce.

Ordinary business common sense will suggest that if it be possible to build ships, which in times of peace could be employed for commercial purposes, and in case of war could be used for the National defense, that from a purely economical point of view, the country would be very much the gainer. It is, of course, true that a great nation must maintain a naval force, and that the men must be trained in actual service, and for that purpose there must always be warships. Besides this, one or more classes of vessels are needed for aggressive and defensive warfare, which are entirely unfitted for commercial purposes. But the exigencies, or rather, the evolution of modern naval warfare, have shown that at least one class of warships must have many features in common with the latest type of merchantmen. In the last report of Admiral Porter to the Secretary of War, it is said that:

In rehabilitating the navy we should ascertain as near as possible the method of fighting by single vessels and in fleets, in order to devise a system of classification which will enable us to use our ships in future combats in the most effective way.

In his report the Secretary of War says:

The experiences of the Department in its first attempt at the creation of modern vessels of war have been such as to excite the greatest concern and disappointment. An examination of the facts with reference to them demonstrated that an entirely new departure was necessary in undertaking further similar construction. The one characteristic which an unarmored cruiser must possess is great speed. This is determined by the function which she is expected to perform in modern warfare. She is a "commerce destroyer." She must be able to escape from iron-clads and outrun, so as to overhaul, merchantmen. If slower than iron-clads she could not keep the sea, and if slower than merchantmen she might as well stay in port. This division of ships by the functions which they are expected to perform is one of the things which has come about of recent years. When it became impossible to concentrate in one ship both the greatest speed, strongest armament and the highest defensive power, without reaching a tonnage displacement wholly out of the question, the division into classes, according to the functions which they are expected to perform, came about. Unarmored cruisers have become a distinct class, and the characteristic *absolutely indispensable to this class is very great speed.*

Admiral Porter says:

We have now reached a point where the greatest speed is demanded for a ship of war. A vessel making but 15 or 16 knots would be useless as a cruiser in time of war, for such a vessel could catch nothing and could not escape from a superior force.

Inasmuch as great speed is indispensable for this class of warships, and also for mercantile vessels engaged in certain kinds of traffic, it would seem to be possible to design ships which could be employed in either service, or at least they might be constructed for mercantile uses, but arranged so that alterations which would fit them for war purposes could be quickly and cheaply made.

The British Admiralty has acted upon this idea and has arranged for the maintenance of a reserve fleet of mercantile vessels suitable and available for use as armed cruisers.

In a communication of Mr. Farwood, Parliamentary Secretary to the Admiralty, to the Secretary of the Treasury, during the present year, it was pointed out that the vessels most likely to suit the purposes of the Admiralty were steamers of such high speed as would in all probability be used for the conveyance of mails and passengers, and it was further stated that the Admiralty considers that no vessel of a speed of less than 17 or 18 knots at sea would fully meet the object they have in view. It was said further that existing vessels, even with this speed, but which have not been built specially to Admiralty designs, would not be so valuable to the country as vessels which meet these requirements. If constructed to meet the views of the Admiralty they would be at a disadvantage in respect to their cargo-carrying powers, and, therefore, it would be a distinct advantage to the country if every reasonable encouragement were given to ship-owners to build and maintain this description of steamers in the trades that may be expected to support them.

Discussing the subject, the Secretary said still further:

The intention of a fleet of "Royal Naval Reserved Cruisers" would be obviously of great National advantage. In a pecuniary sense they would serve to limit the necessity felt by their Lordships for the construction of fast war vessels to protect the commerce of the country. Not only would the Nation be a pecuniary gainer in respect to the first cost of such vessels, but their annual maintenance, which amounts to a large sum, would be saved, were such vessels maintained while not required for Admiralty purposes in mercantile trading.

Regarding the conditions as to vessels to be built it is said:

Plans of two proposed new vessels to be forthwith constructed, and completed in about 18 months, or two years, have been laid before the Director of Naval Construction. That officer has reported that these plans would provide vessels far in advance of anything that has yet been submitted to the Admiralty for the purpose of armed cruisers. They would be of large size, of exceedingly high speed, provided with twin screws, have their engines and boilers placed below the water line, be divided into numerous compartments and have a protected steering gear. * * * Their coal capacity would be such that at a cruising speed they would probably keep the sea for a long period, probably not less than three months.

The question, of course, presents itself whether a ship can be designed which will be economical commercially and at the same time efficient or convertible into an efficient warship in case of need. The British Admiralty evidently are of the opinion that it is possible, and, undoubtedly, if the problem was presented of designing a ship which would be adapted to both kinds of service or which would be constructed with reference to being converted or altered into a warship, the ingenuity of naval constructors would devise methods of doing it.

The advantages of such a system would be very great. Our navy, or a considerable part of it, instead of being useless in times of peace, would be productive. Subventions paid to private parties would encourage and promote our shipping interests. The money paid for constructing and maintaining ships suited for war purposes would help to cheapen transportation, and the service would create a trained body of seamen. It would enlist the knowledge, skill, experience and interest of private parties in designing the most efficient ships for the dual service, and, for a given size of navy, it would lessen enormously the expenditure of the Government for the construction of warships.

THE STRONG LOCOMOTIVE.

A "report and opinion," by E. D. Leavitt, Jr., of tests of the Strong locomotive has recently been issued by the Strong Locomotive Company. The tests were made with three locomotives as follows:

ENGINE NO. 444

was fitted with Strong's patent twin furnace boiler and Strong's patent four-valve cylinder and valve-gear. It had cylinders 20 × 24 in.; six driving-wheels, $62\frac{3}{8}$ in. diameter; heating surface in boiler, 1,848 square ft.; total

weight on driving-wheels, 90,000 lbs.; total weight of engine, 138,000 lbs.

ENGINE NO. 383

had an ordinary straight-top boiler, with fire-box over instead of between the frames, anthracite-coal grates, and fitted with Strong's patent cylinder and valve-gear, similar to that used on No. 444. Cylinders, 19 × 24 in.; four driving wheels, $65\frac{11}{16}$ in. diameter; heating surface in boiler, 1,385.9 square ft.; total weight on driving-wheels, 74,640 lbs.; total weight of engine, 99,520 lbs.

ENGINE NO. 357

had an ordinary boiler, similar to that of engine 383, excepting that it had a "wagon top" eight inches high, and a link-motion, common to American practice, with plain slide valves having De Lancey's balancing device. Cylinders, $20\frac{1}{4}$ × 24 in.; four driving-wheels, $66\frac{1}{4}$ in. diameter; heating surface in boiler, 1,572.1 square ft.; total weight on driving-wheels, 63,280 lbs.; total weight of engine. 90,720 lbs.

The tests were made in April and May, on the Lehigh Valley Railroad, between Wilkesbarre and Mauch Chunk, a distance of 55 miles. A round trip was made each day of the trial. This route is a continuous succession of curves as sharp as 14 degrees, and grades as steep as 96 ft. per mile.

The tests were made with passenger trains, consisting, usually, of eight cars on the northward trip and five southward, which weighed 421,500 lbs. and 253,000 lbs. respectively.

It is not easy to make any exact comparison from the experiments reported, because the loads, the quality of the coal and the sizes of the different engines varied so much. On page 9 of the report, a comparison is made of the coal consumption of each of the engines on two trips, when the same grade of coal (anthracite) was used, and, with one exception, the loads were the same. The performance of the engines on these runs was as follows:

Engine.	Pounds coal consumed.	Pounds water evaporated.	Average pounds water evaporated per pound coal.
No. 444	13,073	102,608	7.8
" 383*	14,883	84,098	5.6
" 357	16,174	96,936	5.9

From this statement it will be seen that the engine with the Strong boiler and valve-gear burned 3,101 lbs. or 19 per cent. less coal than engine 357 with an ordinary boiler and valve-gear did in doing the same work. Engine 383, with an ordinary boiler and Strong's valve-gear, burned 1,291 lbs., or 8 per cent. less coal than 357, although, in this case, on one of its runs engine 383 had a lighter train than 357.

It cannot escape attention, though, that engine 444 with the Strong boiler consumed more water in doing the same work than either of the others, which leads to the suspicion that it does not work dry steam. This excessive consumption of water of course has a marked effect on the evaporation of water per pound of coal. If we compare the total fuel consumption of engine 444 we find a difference, as stated above, of 19 per cent. in favor of the former, whereas it evaporated nearly a third more water per pound of coal than engine 357. In explanation of this, Mr. Strong in a letter to the *Railroad Gazette* says:

First, the fireman of No. 444 had not become sufficiently expert to prevent the blowing off of steam at stations and while running down grade without steam. Secondly, No. 444 has steel valves, which have not worn well, and which leak slightly; whereas the valves in No. 383 are cast-iron, which have worn as smooth as glass and kept perfectly tight. Thirdly, the engineer of No. 444 had not become accustomed to the engine, and carried his water so high that priming occurred; and fourthly, the valve gear of No. 444 was designed after the engine was nearly completed; having to be arranged to accommodate existing parts, its proportion could not be kept as accurately as those of 383's gear.

* On one trip northward the train which this engine drew weighed only 374,300 lbs. instead of 421,500 lbs. in all the other northward runs.

In comparing the performance of these engines, their relative weight should also be taken into account. Engine 444 weighs 38,480 pounds, or 38 per cent. more than engine 383, and 47,280 pounds, or over 50 per cent. more than engine 357. The heating surface of engine 444 is also much greater than that of either of the other engines. A large boiler always has an advantage over a small one when the small one is worked hard. For this reason, although the experiments show a marked economy of the Strong engine over the one of the ordinary type, yet they are not conclusive with reference to the question of the relative economy of the two classes of engines of the same size and weight. The practical question usually is: "Into what form can a given number of tons of iron and steel be put so as to make the most efficient and economical locomotive?" It is doubtful whether this question can be answered by comparing engines as dissimilar in size and weight as those were which were the subjects of the experiments reported on.

The inventor of the Strong locomotive and the company with which he is associated have shown so much enterprise in building engines of this type that every opportunity should and doubtless will be given to them to show what they can do; but to be conclusive a comparison must be made of two engines of similar weight and dimensions, working under the same conditions.

Of course, much allowance should be made for a new machine of this kind. The men who run it are inexperienced in its use and probably not able to work it to the best advantage; and more or less modification of details must always be expected in a machine which is as great a departure from old practice as the Strong engine is, in order to get the best attainable results. Our criticism is not intended as an expression of doubt of the success of this form of locomotive, but is meant to imply that further experiments are needed to demonstrate its capabilities.

Accidents to Employes on British Railroads.

THE last accident report of the British Board of Trade gives some interesting statistics of accidents to employés on the railroads of that country. For the 10 years from 1877 to 1886, inclusive, the number reported is as follows:

	In Train Accidents.		In Other Accidents.	
	Killed.	Injured.	Killed.	Injured.
1877	22	154	620	2,009
1878	15	156	529	1,847
1879	8	118	444	1,836
1880	23	118	523	1,962
1881	19	168	502	2,278
1882	21	153	532	2,423
1883	11	87	543	2,373
1884	23	115	523	2,204
1885	13	81	438	2,036
1886	4	81	421	1,929

The proportion of deaths and injuries to the total number of employés is given for each year in the report; it is, however, based on estimates only, except in the year 1884, when a special return made to Parliament gave the total number of men employed on the railroad lines of Great Britain as 346,426. Accepting the estimated figures, however, as nearly correct, the returns show that there has been a continuous and marked decrease in the proportion of casualties. In 1877, there was 1 person killed to 414 employed, and 1 injured to 123; in 1886, the proportions had fallen to 1 in 815 killed and 1 in 172 injured, a very substantial improvement. This improvement, moreover, was not spasmodic, but steady and continuous.

As to the relative dangers involved in the different kinds of employments on railroads, the following table is given. In this, the Board takes the total number of employés killed and injured (in train and all other accidents) in 1886, and compares them on the basis of the return of 1884, the Board believing that the total number of employés has not changed since then greatly, or indeed more than it ordinarily fluctuates from month to month. This table is as follows:

	Total No.	Killed.	Injured.
Station-masters	6,165	1 in 1,027	1 in 1,027
Brakemen and goods-guards	7,407	1 in 192	1 in 18
Permanent-way men	37,840	1 in 411	1 in 261
Gatekeepers	1,605	1 in 321	1 in 535
Engine-drivers	12,874	1 in 1,609	1 in 90
Porters and shunters	48,070	1 in 546	1 in 84
Firemen	12,795	1 in 711	1 in 65
Inspectors	3,518	1 in 586	1 in 207
Passenger guards	5,902	1 in 2,951	1 in 100
Pointsmen and Signalmen	19,012	1 in 1,728	1 in 487
Laborers	70,405	1 in 1,902	1 in 977
Ticket collectors, etc.	2,060	1 in 1,030	1 in 1,038
Mechanics	55,940	1 in 6,213	1 in 2,331
Other classes	62,833	1 in 604	1 in 411
Total	346,426	1 in 815	1 in 172

Some of the conclusions above shown accord very nearly with our experience in this country. That the proportion of casualties should be very high among brakemen and goods-guards (or freight conductors), among porters and shunters (or yardmen) and among engineers and firemen we would naturally expect; but why gatemen should stand only second in the proportion of killed is not easy to be seen.

Nearly 30 per cent. of the deaths and over 60 per cent. of the injuries not due to train accidents were due to operations connected with the shunting or shifting of cars. The car coupler is a question intimately connected with the safety of trainmen in England as well as here.

The following table shows the number killed and injured in shifting or yard work, the first column giving the casualties resulting directly from coupling or uncoupling cars; the second, the total number of shifting casualties its figures therefore necessarily including those of the first column as well:

	Coupling.		All Shunting.	
	Killed.	Injured.	Killed.	Injured.
1877	..	...	167	1,175
1878	44	313	124	1,051
1879	25	304	99	1,047
1880	40	298	127	1,141
1881	35	377	125	1,339
1882	34	429	121	1,556
1883	45	395	130	1,449
1884	29	341	91	1,320
1885	36	267	138	1,236
1886	23	301	119	1,168

It can hardly be said that this table shows an improvement, although the figures for 1886 are somewhat better than those for the preceding year. At best, it may be said that the increase in accidents of this class has not been greater than that in mileage and traffic, and that they have remained about stationary.

Assuming the same basis as that taken by the Board of Trade in the table given above, and taking the classes of men usually employed in shifting operations, we find that in 1886 the proportion of casualties was 1 in 466 killed and 1 in 47½ injured in all shifting work; 1 in 2,412 killed and 1 in 184 injured in the actual coupling and uncoupling of cars.

It is very much to be regretted that there are no statistics in existence which would make a comparison possible between the railroads of Great Britain and those of the United States. On the railroads of Massachusetts, in 1886, the average number of persons employed was 31,188, and the total number of casualties to employés reported was 63 killed and 211 injured; an average of 1 in 495 killed and 1 in 148 injured, or a very much worse showing than that made by the English railroads. Some of this difference may be due to the fact that the English returns include a larger proportion of warehouse laborers and station men, who can hardly be said to be exposed to the usual dangers of railroading.

In Massachusetts, in the same year, 2 men were killed and 105 injured in coupling cars; in this case, so far as a comparison can be made, it does not seem as if much advantage could be claimed for either side.

NEW PUBLICATIONS.

Report of the Aqueduct Commissioners of New York City; by the President, James C. Spencer, containing Reports of the Secretary, John C. Sheehan and of the Chief Engineer, Benjamin S. Church, giving a Review of the Work of the Aqueduct Commission to January 1, 1887, including the Plans and Work of Construction of the new Croton Aqueduct to that date, and the proposed Dams and Reservoirs and other Appurtenances of the same, made in accordance with the Resolutions of the Aqueduct Commissioners.

This is a large quarto book, very elaborately illustrated with lithographs and prints by the Photo-Gravure Company, of New York. The report of the President gives a history and brief description of the development and progress of the great work. The Secretary's report gives statements of the appropriations and the amounts expended each year since the inception of the construction of the Aqueduct, with a list of the officers and engineers employed on the work.

The report of the Chief Engineer is the most interesting and valuable portion of the volume. It is accompanied with elaborate tables, profiles and diagrams, giving data concerning the water supply from the Croton River and the rainfall in its basin. There are also a series of tables and diagrams giving the particulars relating to contracts, progress of work, constructors' plant, etc.

The photo-gravures show the various structures, both permanent and temporary, which have been erected along the line of the aqueduct and illustrations taken in the interior of the tunnels with electric lights. There are a large number, between 40 and 50, of these illustrations, which show the work in its various stages of progress. These are followed by 32 full-page "progress profiles," showing the rate at which the work has advanced. Elaborate maps and profiles show the location of the aqueduct, and the various gate-houses, arrangement of pipes, overflow structures, shafts, sections of masonry, waste weirs, machinery, instruments employed, plans of reservoirs, dams, etc., are shown by a series of some 60 lithographed drawings, which are exquisite specimens of the draftsman's art.

Altogether, the book is a model of its kind, the expense of which is justified by the magnitude of the work entrusted to the Commissioners and the Engineers.

REPORT OF THE PROCEEDINGS OF THE TWENTIETH ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

This report has been very promptly issued by the Secretary, and this year contains 211 pages, about the usual number. Its general character does not not differ materially from the reports published in previous years.

BOOKS RECEIVED.

R. UNIVERSITA ROMANA, SCUOLA D' APPLICAZIONE PER GL' INGEGNERI: ANNUARIO PER L' ANNO SCOLASTICO 1887-88. PROGRAMME D' INSEGNAMENTO; INDICE GENERALE DELLA BIBLOTECA. Rome, Italy; issued by the Royal University.

ANALES DE INGENIERIA: ORGANO DE LA SOCIEDAD COLOMBIANA DE INGENIEROS. Bogota, Colombia; issued by the Society, Manuel Antonio Rueda, Director.

TICKET AGENTS' AND TRAVELERS' RAILWAY, STEAMSHIP AND STEAMBOAT GUIDE: VOLUME 1, NUMBER 1, SEPTEMBER, 1887. New York, 51 Park Place; Henry G. Marsh, Editor and Proprietor. This new guide or manual is especially useful to ticket agents, but travelers will also find it of value. It contains a great deal of information in a compact form.

POOR'S MANUAL OF THE RAILROADS OF THE UNITED STATES: 1887. New York; H. V. & H. W. Poor. This is the twentieth annual issue of the well-known *Manual*, which has come to be accepted as a standard work.

THE UNIVERSAL TINKER AND AMATEURS' ASSISTANT: SEPTEMBER, 1887. New York; Hodgson & Bertrand. This is a new monthly journal, issued by the publishers of the *Builder and Woodworker*. Its purpose is well indicated by the title.

ANNUAL REPORT OF THE COMMISSIONER OF PATENTS: 1886. Washington; Government Printing Office.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY: ABSTRACT OF PROCEEDINGS OF THE SOCIETY OF ARTS FOR THE TWENTY-FIFTH YEAR, 1886-87. Boston; issued by the Institute.

THE NEW CROTON AQUEDUCT OF NEW YORK: REPORTS OF THE AQUEDUCT COMMISSION, 1883-87. New York; published by the City. This volume contains the reports of President James C. Spencer, Secretary John C. Sheehan and Chief Engineer Benjamin S. Church, and is accompanied by a large number of plates showing the progress of the work and many interesting points in relation to it.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION: PROCEEDINGS OF THE TWENTIETH ANNUAL CONVENTION. Chicago; issued by the Association. This report of the convention held in St. Paul last June appears with commendable promptness.

BREAKAGE OF WHEELS AND TIRES ON BRITISH RAILROADS.

(*Concluded from page 427.*)

The year 1881 apparently closed the period when breakages of tires were considered of importance enough to need investigation, for since that year there have been no cases in which such accidents have been specially reported on to the Board of Trade by its Inspectors.

The total number of accidents reported as occurring from breakages of wheels and tires in the five years from 1882 to 1886 was as follows:

	Broken tires.	Broken wheels.	Total.
1882	1,149	1	1,150
1883	1,247	3	1,250
1884	1,060	2	1,062
1885	920	1	921
1886	866	1	867

No persons were reported killed or injured in any of these accidents except in one, in 1882, when three passengers were slightly hurt. That they were generally of a slight nature is further shown by the fact that it was not considered necessary to enquire into any of them.

The general remarks of the Board of Trade on this class of accidents, for the years named, indicate that there had been a general improvement in the methods used of fastening tires to the wheel-centers, and that to this improvement was due the generally slight nature of these accidents. While many cases of broken tires still occur, there are comparatively few in which the tire leaves the wheel altogether, as was noted in many of the earlier accidents. By far the greater number of breakages were under freight cars, where injury to persons is not likely to result; and a large number were merely slight breaks, which disqualified the tire for further service, but did not result seriously to the train.

As in former years, the breakages of wheels, apart from the tires, were so few in number as hardly to deserve special mention.

The Mineral Riches of the Caucasus.

(From the *Revue Scientifique.*)

THERE is hardly any portion of the globe which is as rich as the Caucasus in different minerals. In all the country known as Transcaucasia, from the chain of the Caucasus on the north to the Persian frontier on the south, and from the Caspian Sea on the east to the Black Sea on the west, minerals and metals abound.

The government of Yelizavetpol merits special mention; it is one of the richest provinces of ancient Armenia; the sub-soil of whole districts consists of an ore of copper rich in metal (10 to 20 per cent.) which crops out in many places. Other valuable ores are also found, notably argen-

tiferous galena yielding up to 17 per cent. of silver and 60 per cent. of lead. There are also deposits of iron ore—principally magnetic and specular ores—with 70 and even 80 per cent. of metal. Cobalt is also found there in considerable quantities.

Iron ore, in various forms, is equally abundant in the government of Tiflis, at Tchatah, in the districts of Charopan and Ratcha, and at Batoum, where argentiferous copper is also found.

Gold is found in some quantities in Mingrelia and in the bed of the River Ingour.

The oxide of manganese (MnO^2) exists in large quantities in the governments of Koutais, Tiflis and Yelizavetpol; at present it is only worked in the Valley of Kvirilla, in Koutais.

The government of Erivan has, besides other minerals, enormous deposits of rock-salt.

Sulphur is found in a native state in several places, especially in Daghestan, where it is regularly worked.

One of the most valuable riches of the Caucasus consists in the well-known deposits of petroleum in the Apcheron peninsula, near Baku, and northwest of the Koubon Range. There are good reasons for believing that this valuable product is also to be found in large quantities on the shores of the Black Sea, between Poti and Batoum, near Ozourgeti. Borings have been in progress there for some time.

In other parts of the country there exist deposits of minerals of less importance; among these are zinc, antimony, saltpeter, soda, marble, gypsum, ochre, lithographic stone, fire-clay, ozokerite, etc.

For the working of mineral deposits on a large scale, two things are necessary: Cheap and abundant fuel, and facilities of transportation.

The country is traversed by the railroad from Batoum to Poti and Baku. The places richest in minerals are at a distance from that line varying from 10 to 50 miles. There are good roads reaching the railroad and numerous water-courses which might be utilized in improving communications. The cost of wagon transportation is still low in the Caucasus, especially in the eastern portion of the country.

As to fuel, the western portion of the Caucasus is heavily wooded, the eastern section much less so. Wood, however, is not indispensable; the country possesses a valuable fuel in the refuse from the petroleum refineries, known as "Astatki" or "Mazout." Its calorific power is high and it is easily transported. Besides this, there are important deposits of coal in the government of Koutais, at Tkvibouli. The workings at that place have just been connected with the railroad and will soon be in a position to furnish fuel advantageously to all the country. Labor at the coal mines and elsewhere is now very cheap and fairly reliable.

In addition to the advantages already mentioned, is the further one of easy access to the extensive market of Russia, and also to the markets of the neighboring countries, Turkey and Persia.

While many of these minerals have long been known to exist, the workings have been only on a small scale to supply local needs; the methods used have been very rnde and primitive.

A beginning has, however, been made, and so far with success. The firm of Siemens has, for 20 years, worked the copper mines at Kedabek, in the government of Yelizavetpol. This year a French companv has bought the silver mines at Achtala, and has commenced its workings there.

Very little has been done heretofore, because the people of the country have had neither the technical knowledge, the enterprise, nor the capital needed for operations on a large scale. The Caucasus can, however, become the seat of a great industrial activity, for which it presents so many advantages.

The great drawbacks to be encountered are the variety of dialects spoken by the natives of the country and the fact that they are not accustomed to regular work; and, above all, the corruption and maladministration of the Russian Government officials. For these difficulties a foreigner must be prepared.

OBITUARY.

Joseph S. Salisbury, who died at Missouri Valley, Ia., August 31, aged 44 years, was born in Jefferson County, N. Y., but went West at an early age. He practised law in Iowa for a time, but some years ago settled in Chicago and became Editor and one of the proprietors of the *Industrial World*. He has conducted this paper with much success. He has been in failing health for some months past.

J. B. Clough, whose death at Helena, Montana, August 3, was briefly noted last month, began work as an engineer in the capacity of an assistant in the location of the Mobile & Ohio in 1849. In 1851, he was on the Cleveland & Pittsburgh, where he remained several years. In 1860, he was Chief Engineer of the Evansville, Henderson & Nashville. In May, 1861, he was appointed Constructing Engineer of the United States military railroads in Virginia, and organized a construction corps, which he commanded until December, 1864, when he resigned on account of ill-health. At that time he was Brevet Colonel of Volunteers. In 1867, he resumed work and was appointed Chief Engineer of the Hastings & Dakota Railroad. In 1869, he was elected City Engineer of Minneapolis, and, in 1870, he became Chief Engineer of the Minneapolis & St. Louis road and remained in that position for several years. In 1880, he entered the service of the Northern Pacific Railroad, having charge of the construction of the bridge over the Missouri River at Bismarck and its approaches. For some time past he has had charge of the location and building of branch lines in Montana for the company.

Contributions.

The Proportions of Locomotive Cylinders.

To the Editor of the Railroad and Engineering Journal:

Referring to the article in the September number of the Railroad and Engineering Journal, on "Proportions of Locomotive Cylinders," on page 414, you give

$$\sqrt{\frac{60{,}000}{4}} \times 61 \over 136 \times 26} = 16.1 \text{ (or } d\text{)}.$$

If you try it as it is written, the result is absurd; it should be

$$\sqrt{\frac{\frac{60{,}000}{4} \times 61}{136 \times 26}},$$

or the square root of the whole.

Again, on page 415, try the formula for weight as given, of which I enclose a sample, and the result is also ridiculous. The formula should be $\frac{d^2 (P \times 0.85 \times S)}{C \times D} = W$, or else the C should not be taken as $\frac{1}{4.25}$, but 4.25, a constant.

For years I have maintained that engines have been, and mostly are, over-cylindered, and I am glad to notice that others are coming to the same belief.

J. H. Ames.

[Note.—In his first exception our correspondent is partly right. The radical sign $\sqrt{}$ was intended to cover the whole fraction, but the printer, not being a profound mathematician, did not make it quite long or comprehensive enough, and so there is fairly a doubt as to its correctness as it stands.

The error in the last formula must be laid to the committee which made the report. As pointed out by our correspondent, the value of C should be 4, 4.25 or 4.5,

instead of $\frac{1}{4}$, $\frac{1}{4.25}$, or $\frac{1}{4.5}$. The formula $\frac{d^2 \times S \times P \times 0.85}{D}$ will give the tractive power of the cylinders. Obviously the weight on the drivers should be four times the tractive power, if the adhesion is taken at $\frac{1}{4}$ the weight on the wheels.—EDITOR RAILROAD AND ENGINEERING JOURNAL.]

Pillsbury Flouring Mills at Minneapolis.

ONE of the sights in Minneapolis which most strangers are taken to see are the Pillsbury flouring mills. There are three of these, Mill A being the largest. A card which is handed to visitors gives the following facts: "Mill A grinds 9,500,000 bushels of wheat yearly, and has a capacity of 7,000 barrels of flour daily. It makes more flour than any other two mills on the globe, and could feed two cities as large as New York."

It is located on the Mississippi River, which furnishes the water power. The water is brought to the mill by an arched tunnel 50 rods long and 20 ft. high by 16 ft. wide. There are two turbine wheels, manufactured by the Stillwell & Bierce Manufacturing Company, of Dayton, O. The turbines are 55 in. diameter and have 52 ft. head of water, and are each of 1,200 H. P. Besides the water power the mill has an additional reserve steam power, consisting of a compound engine of 1,600 H. P., which is supplied with steam by ten steam boilers. The engine was made by Edward P. Allis & Co., of Milwaukee, and has 5 ft. stroke with two cylinders, one 60 and the other 32 in. diameter. The fly-wheel is 24 ft. diameter with 5-ft. face and a shaft 14 in. diameter and makes 70 revolutions per minute. The wheel weighs about 30 tons. Its belt consists of three-ply heavy leather, 5 ft. wide, and drives a pulley 16 ft. diameter. The steam power is used only in time of low water, which may occur either in the cold or the dry season of the year.

The mill is 115 ft. wide, 175 ft. long and 20 ft. high, and is eight stories high. The basement is chiefly occupied by heavy machinery and its appurtenances. To a person who knows nothing about milling machinery, excepting what he learned in his youth, the wonderful variety and ingenuity of the machinery employed in one of these modern structures is quite a revelation. The processes of making flour and the product have been wonderfully improved, and a visitor can understand why it is no longer possible for smaller mills to compete with these enormous establishments.

Methods of Securing Tires on the Wheels.

THE accompanying engraving, fig. 1, represents a plan largely used for some time past in Austria, in Germany and in Belgium; the Southern Railroad Company of France has applied it to all the wheels used on its passenger carriages and freight cars.

This system consists of a ring or circular key, *A*, of steel, which is rolled or hammered in a straight bar and cut off to a fixed length, the ends being cut at an angle of 45°. This bar is then bent or curved, either hot on a mandril or cold on a system of three rolls, and is sprung into place as soon as the tire has been forced on the wheel-center.

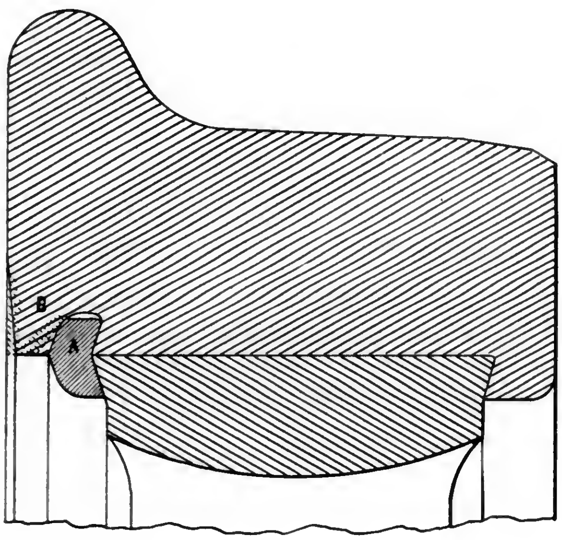


Fig. 1.

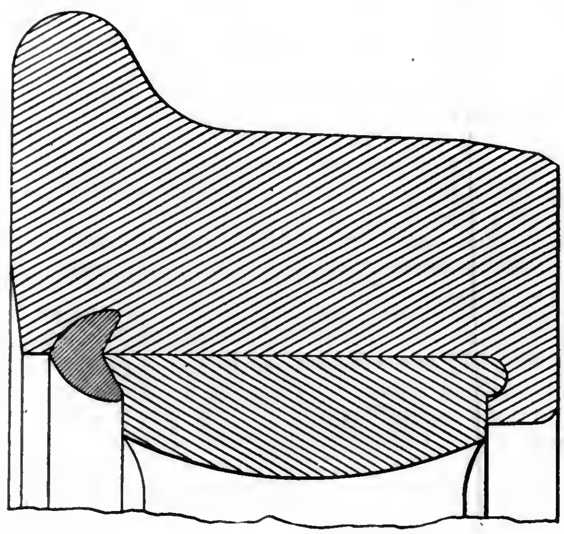


Fig. 2.

METHODS OF SECURING TIRES TO WHEELS.

Both the tire and the wheel-center have the exact form of the inner side of the ring, and the channel or groove in the tire is made as shown by the dotted lines in the drawing. As soon as the tire has been shrunk on the center the lip *B* is hammered down, thus fixing the ring in place and preventing all displacement. This method of fixing the tire gives absolute security in case of breakage, as the tire cannot leave the wheel.

The second drawing, fig. 2, shows a plan for securing tires adopted by M. Rodieux, Chief Engineer of Material and Motive Power of the Western Railroad of Switzerland at Yverdon, and used by several of the Swiss railroads. This system differs from that shown in fig. 1 only in the more simple form of the key, and also of the grooves in the tire and in the wheel-center to which it is applied.

CHOMIENNE.

COUZON, FRANCE, July 30, 1887.

THE MILLER PLATFORM AND COUPLER PATENTS.

(*Continued from page 402.*)

In this article it is proposed to deal with the questions which arose as to the 1865 patent of Miller. The complainants seemed to place much stress upon this patent, and especially upon the fourth claim. Originally the first claim also of this patent was pressed, but upon the hearing this claim was abandoned and no testimony regarding it was offered.

The first claim was as follows:

> 1st. So constructing hooked head car-couplings that they are adapted to receive links and other forms of couplers and form connections therewith, substantially as described.

This is effected in the Miller structure of 1865 by boring a vertical hole through, and by having a horizontal slot in the hooked head. In this way an ordinary link and pin can be used in connection with the Miller mechanism.

It seems evident that, after such holes had been bored and slots provided in other forms of couplers, no invention was required to do the same thing in the case of the Miller structure. The defendants produced a number of old patents, long prior to Miller's patent of 1865, which showed various forms of couplers, the arrangements of which were such as to greatly limit the scope of Miller's patent, and, according to the views taken by the defendants, one of these old patents showed Miller's invention. As this claim was withdrawn during the trial, nothing more need be said about it here, especially as it is not a matter of interest connected with the trials of the case.

The fourth claim was the one upon which stress was placed. This claim reads as follows:

> 4th. Locating an elastic buffer in the end of the buffer-beam *A*, of a platform which is elevated so as to be brought in a horizontal plane with the bed of the car-body, substantially as described.

Both sides understood that what was meant by the "end" of the buffer beam *A* was the center of the beam or the extreme end of the platform longitudinally of the car.

The accompanying drawings, taken from the patent of

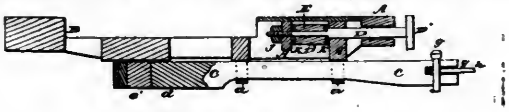


Fig. 7.

MILLER PLATFORM, 1865.

Miller, will give an understanding of the devices as shown in the patent.

The first cut gives a longitudinal section of the platform and bolster beam, showing also the coupler attached to the car. The second cut gives a view of the bottom of the platform and bolster beam, also showing the coupler.

Now it becomes interesting to see exactly what Miller said about this elevated platform in his patent, and it will be found that he said very little.

> Another object of my invention is to provide for connecting together each one of a train of cars in such manner that the lateral jerking motion of a train, and all the unsteadiness and injurious effects occasioned thereby, will be effectually prevented, providing at the same time for resisting the longitudinal shocks occasioned by suddenly starting and stopping a train of cars, employing for said purposes a contrivance which is located in a line with the strongest part of a car-body—viz.: the flooring timbers—as will be hereinafter described. * *
>
> As my invention is applicable to cars which are constructed in the usual manner, I have only represented in sheets 1, figs. 1, 2 and 3, the platform and longitudinal supporting beams thereof of one end of a car. I will, however, state that, in order to carry out one part of my invention effectually, it is desirable to have the transverse buffer-beam *A* of the platform frame elevated, so as to bring it in or nearly in a plane with the car-bed or frame timbers of the car-body. This will bring the platform or floor thereof in a horizontal plane, or nearly so, with the floor of the car without necessarily elevating the transom *B*. * * * *
>
> Above the coupling hook *C*, and extending longitudinally through the buffer beam *A*, and into the framework of the platform, is a buffer-shank, *D*, which is constructed with an enlarged head, *D'*, on one end and a round or cylindrical extension, D^2, on the other end.

It will be seen out of the matter quoted but one meager sentence refers particularly to the elevated platform. The other sentences quoted referring to the location of the buffer, its construction and arrangement.

The first thing to be noted is that Miller does not claim an elevated platform *by itself;* he only claims such a platform when an elastic buffer is located in the position shown. When a thing is not claimed in a patent by itself, but only in combination with some other device, the separate devices making up the combination are supposed to be in and of themselves old in the art.

Thus the inference from reading the fourth claim of Miller's patent is that elevated platforms were old, but that they had never before his time been combined with elastic

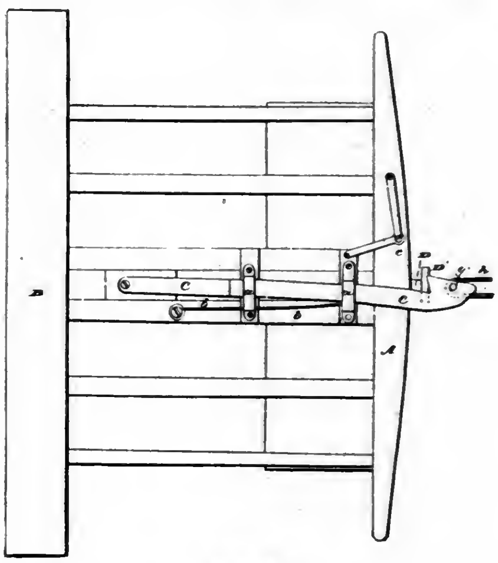


Fig. 8.

MILLER PLATFORM, 1865.

buffers located in their ends. The complainants at the trial made a great point of the benefit arising from the use of elevated platforms, *per se*, which point was admitted by the defendants. The defendants, however, asserted that the elevated platform as used to-day was not by itself the invention of Miller. To prove this, the defense put Mr. Calvin A. Smith upon the stand. Mr. Smith is the Superintendent of the Union Tank Line. From or about the year 1854 to 1874, Mr. Smith was employed as General Foreman and Superintendent of the Car Department of the Erie Railroad. In the year 1862, at the Erie shops, three cars were put in the course of construction, having elevated platforms. The Erie road was a broad-gauge road, the cars rocked a good deal and it was desired to lower the car-bodies as much as possible.

To do this and still keep the draft-line at the then normal height above the rails, required that the car-bodies should be lowered without lowering the couplings. This could only be done by elevating the platform, or rather keeping the platform at its then height, while the car-body was lowered.

The draw-bar passed through the center of the buffer-beam. In this way, which was substantially in accord with modern practice so far as the platform was concerned, Smith says he built three cars—one was put in use in May, one in June and the last in September, 1863. Miller, it is said, was in and out of the Erie shops at that time, and from the testimony it is probable that he saw some or all of the three cars.

No testimony was offered by the complainants which it is thought shook Mr. Smith's evidence. Mr. Palmer R. Post was put upon the stand by the complainants, and he swore that he did not remember seeing the cars described by Smith, though he was connected with the Erie Railroad at the time.

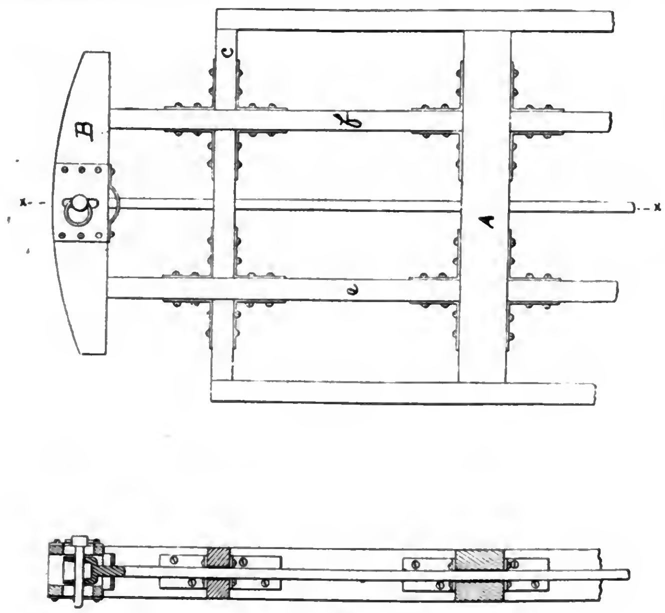


Fig. 9.
OLD GERMAN CAR.

The defendants next in the order of their defense put in evidence a number of patents showing platforms level with the car-beds or sill timbers. As a matter of fact, it appears that in the early days of railroading the platforms were usually made level with the sill timbers by carrying the sill timbers out beyond the car-body and thus forming the platform. This form of structure was departed from when the wheels were increased in diameter, the car-body consequently raised, while the draft-line was kept at the same height. This brought into use the depressed platform, which finally gave way in time to the elevated platform, now used with the more elevated draft-line.

The defense relied largely upon a drawing appearing in an old German publication entitled *Organ für Eisenbahn Wesen*, Vol. 5, page 49. This publication was printed about 1850. In it is shown a drawing of a car. The car has four longitudinal timbers or sill beams. It has a bolster-beam and a buffer-beam. There is a coupler and buffer at the center of the buffer-beam. As will be seen from the drawings given, it is impossible to tell therefrom whether the center sill timbers were stopped at the bolster-beam, or whether they were halved into the beam, or exactly how the parts were arranged in this regard.

However, this structure showed an elevated platform exactly in line with the sill timbers of the car. The complainants said it was not an "attached platform," that is, one which could be taken off for repairs, but that to repair it would require a rebuilding practically of the whole car-bed. It was suggested in answer to this by the defendants that the Miller drawing itself did not show how the sill timbers were to run, the top of the bolster beam being as high as the top of the platform, and that the Miller patent was as blind as the German drawing.

The complainants in answer to this said that the longitudinal sill timbers of the German car were to be halved into the bolster.

The third cut (fig. 9) is a drawing of the old German car. Steps were used and the platform was narrow to allow of their use.

Referring to the above drawing, *A* is the bolster beam, *B* is the buffer beam and *C* is the front transverse sill beam. From the drawing it is clear that the two outside longitudinal beams ran to the beam *C*, that the two center-beams were stopped at the beam *A*. Now the defendants insisted that the beams *e* and *f* were halved into the beam *C*, while the complainants insisted that the beam *C* was made in three pieces and that, therefore, the structure was a weak and useless one. It is submitted that to any mechanic the plain interpretation of the drawing is that the beams *e*, *f* and *C* were halved into each other.

The defendants next in the order of their defense showed numerous examples of cars having buffers located in the end beam of the car-body as in the case of English cars, and insisted that the question of an "attached" platform was immaterial. The English cars were all provided with side buffers, but it is to be borne in mind that the cars of the Pennsylvania Railroad Company had no central buffer through the end beam of the platform or buffer-beam. The buffers, it is true, were not separated in the cars of the Pennsylvania Railroad Company to as great an extent as in the English cars, but, nevertheless, they were not central or axial buffers, and it was merely a question of degree in this regard between the English buffers and the buffers of the defendant corporation.

The complainants further insisted that the buffer of the 1865 patent must be a buffer which sent the strain backward through and in line with the sill timbers of the car. This action, the defendants insisted, could not be obtained with the defendants' system, and, therefore, it did not infringe, as no buffing strain could be imparted to the car above the pivot of the yoke lever, and the location of this pivot is some inches below the sill timbers. This the defendants considered a point of such importance that in itself it should have been sufficient to win them the case. (See previous cut of Janney device in earlier number.)

There is nothing in the 1865 patent of Miller which confines the invention strictly to a buffer which went entirely through the buffer-beam, and consequently the defendants insisted that the invention was met by cars having level platforms with buffers upon but not through the end beam.

The fourth cut (fig. 10) shows cars so constructed.

The drawing is taken from the patent of Peter Alverson, No. 908, September 8, 1838, and shows that it was very old to use buffers on the buffer-beam of a platform level with the car-body.

In this same connection the patent of Turner, granted in 1848, showed a car having a level platform, made by extending the sill timbers of the car, and having a buffer

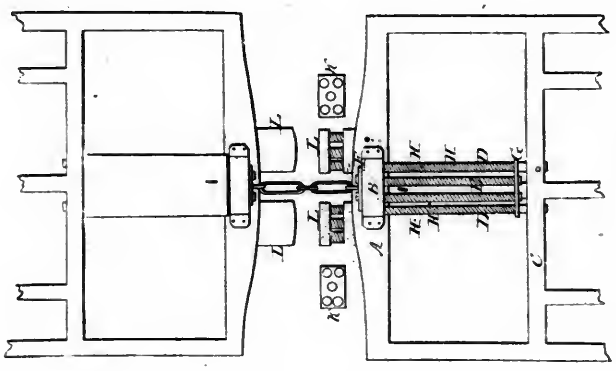


Fig. 10.

ALVERSON CAR, 1838.

in the buffer beam. This buffer is just below the sill timbers, but, as the Pennsylvania Railroad Company cars have the point of strain of the buffers below the sill timbers, this Turner patent was urged as a good reference.

The fifth drawing (fig. 11) is a cut showing an end view of this car. The buffers were also to act as coupling devices, and were likewise to put the brakes upon the wheels.

To these old patents the complainants replied that in each case no "attached platform" was shown, and that a platform made by the extension of the longitudinal timbers of the car would not meet the Miller patent of 1865,

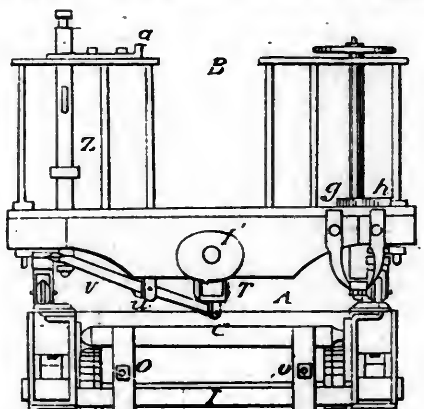


Fig. 11.

TUMER CAR, 1848.

which was limited, so the complainants said, to an "attached platform." The Court in this matter, during a discussion between counsel in the absence of the Jury, gave its views on the subject of this claim. The discussion arose as to how the claim should be understood; complainants insisting that it was limited to an elevated platform made by attaching the timbers of the platform to the sill beams, while the defendants insisted that this made no difference, and that however the platform was elevated, whether by attaching the beams to the sills by bolting them thereto or by carrying out the sill beams, was of no consequence, and that Miller had claimed *any* elevated platform with a buffer at its center or in its "end," as he called it, independently of the question how, mechanically, the platform was elevated. If the Court had charged the Jury in accordance with the complainants' view the defendants had no anticipation. If the Court had charged the Jury in accordance with the defendants' view, then the old German car was clearly an anticipation of the claim of Miller.

This is what the Court said in part:

I have read the patent through, and I confess I find no warrant in the patent itself for saying that there is any mode or method of constructing elevated platforms in it. If it is an elevated platform—that is in the sense that it is on a level with the car timbers—it seems to me that is all that is contemplated in the claim. I do not see how you can import into that claim any particular way of getting that platform on a level with the sill timbers. One can do it in one way, and one can do it in another; however he does it he has infringed Mr. Miller's claim. * * * *

It does not make any difference how you get your platforms up. * * * *

He (Miller) could not have intended to cover any particular construction of platform by that claim (the *4th* of the 1865 patent) or he would have put it into his claim, and not having done that the fact that the drawings show it (a particular method) does not affect the question at all. * * * *

How can I say, however, that he means one kind of platform made in a particular way. I do not see anything to justify it.

From the above it is clear that the Court, if the case had gone to the Jury, would have given such instructions to them that they would have had to have found that the old German car showed a structure which met the claim. This is the only way in which this claim was passed upon, the patent having finally been taken away from the Jury altogether by the Court. However, from the above remarks of the Judge, it is clear that in his view, the patent could not have been construed as for the particular elevated platform shown by Miller in his drawing, but that the claim was so broad as to include the earlier forms of elevated platforms, and the claim was therefore void.

The Use of the Water Jet for Increasing Adhesion in Locomotives.

ONE of the questions submitted to railroad companies, by the International Commission of the Congress of Railroads, was as to the question of the use of a jet of water or steam to increase the adhesion of locomotive wheels.

The companies have submitted answers to this question, which are published in the *Bulletin* of the Commission. The Belgian State Railroads report some experiments made on the Liège inclines, and also on the Hockai inclines, with no very definite results.

The Eastern Railroad of France made a few experiments which resulted in nothing.

The Mediterranean Railroad of Italy submitted an elaborate report by Chevalier J. Silvola, which informs us that experiments were begun in 1879 on the Pontedecimo -Busalla Line, which were so successful that the water-jet was applied to 35 of the eight-coupled locomotives used on the heavy grades of that line. This resulted in a considerable saving, the expenditure for sand having been 20,000 francs a year, while the cost of the steam or water-jet was only about 2,500 francs.

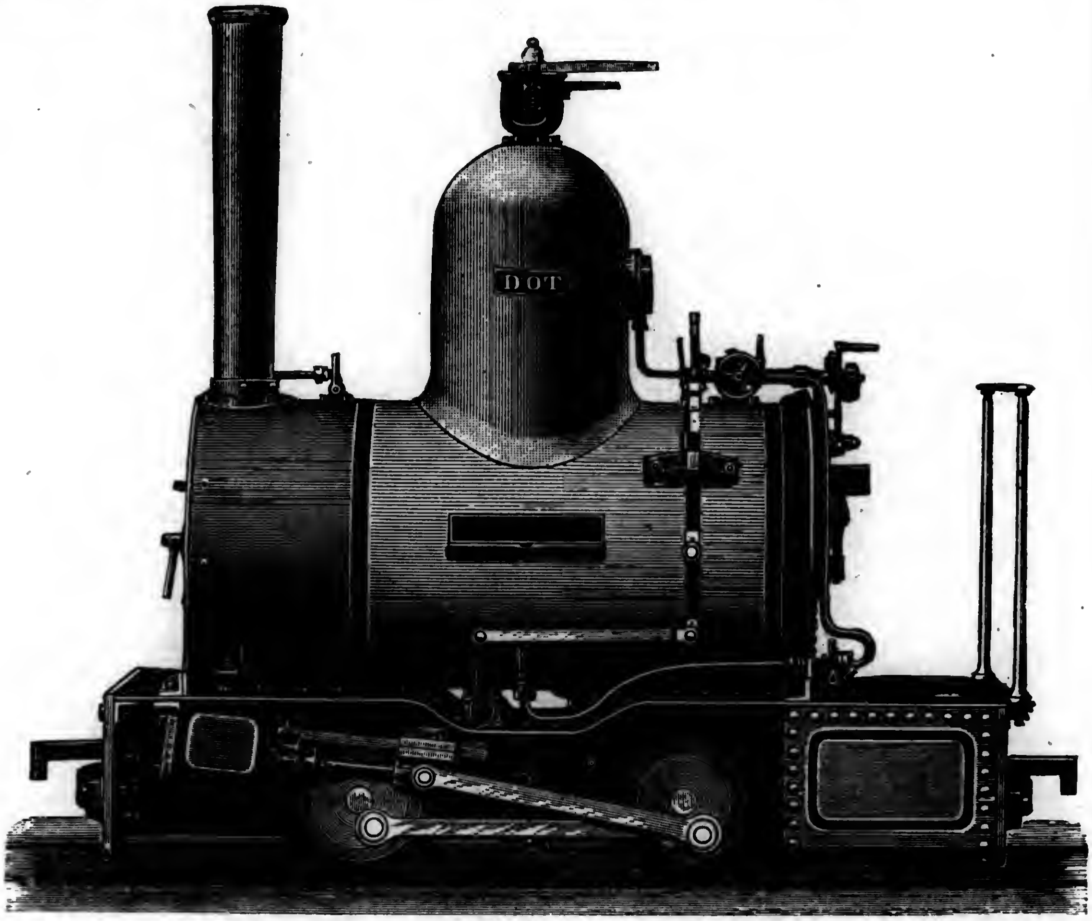
An incidental advantage was the absence of the sand, which at one time proved a serious obstacle in the way of maintaining good drainage in the Giovi Tunnel.

The further opinion is advanced that while the adhesion is not increased quite as much by the use of water as of sand, the water-jet system has the advantage in that it does not interpose any resistance to the movement of the train as does the sand, more or less of which remains on the rails. The engine-drivers much prefer the water-jet system as they say it makes the train ligher—that is, it

draws more easily. It is stated also that the abandonment of the use of sand is accompanied by a lessening of the wear of rails. This result is supported by numerous observations, and is further corroborated by the observations of M. Couard on the Sorderettes Tunnel of the Paris, Lyons & Mediterranean Railroad, and those of M. Egger on the Swiss Central Railroad.

The water-jet system, it has been said, will not answer in cold climates, but it has been very successful on the Swiss Central and the Gothard lines, both of which are subject to very low temperatures. The Gothard Railroad has 55 locomotives fitted with the water-jet, and thoroughly approves the system. On this road, although there are long tunnels and steep grades, making the use of heavy locomotives necessary, the wear of the rails has been much lighter than was expected.

Total wheel-base	33 in.
Boiler, diameter	27 in.
" length	51 in.
Fire-box, cylindrical:	
Diameter	17 in.
Length	27⅜ in.
Tubes, 55 in number:	
Length	24 in.
Outside diameter	1⅜ in.
Grate area	1.8 square ft.
Heating surface:	
Fire-box	10.9 square ft.
Tubes	39.5 " "
Total	50.4 " "
Extreme length of engine	7 ft. 6 in.
Extreme width of engine	3 ft. 0 in.



SHIFTING LOCOMOTIVE OF 18 INCHES GAUGE.
BUILT BY BEYER, PEACOCK & CO., GORTON, MANCHESTER, ENGLAND.

The results so far obtained justify the making of extended experiments with the water-jet system, in the opinion of the Commission.

The Smallest Locomotive.

As an example of a very small locomotive we reproduce herewith, from *Industries*, an engraving of a locomotive shown at the Manchester (England) Jubilee Exposition, by Messrs. Beyer, Peacock & Co. The engine is intended for switching and moving material through shops and yards, and several of this class are in use in the works of the firm at Gorton, Manchester. Several have also been built for use in the Lancashire & Yorkshire Railway shops at Horwich.

The leading dimensions of this engine are as follows:

Gauge	18 in.
Cylinders, diameter and stroke	5 × 6 in.
Number of wheels, 4; diameter	16¼ in.

As will be seen from the engraving, the cylinders are placed outside. The boiler is a plain cylinder in form, the fire-box being also cylindrical.

The tank carries 25 gallons of water. The total weight in full working order is 3¼ tons.

Steel Scale Produced by Skidding Railroad Wheels.

[Paper read before Section G, British Institution, by Jeremiah Head, Vice-President of the Section.]

WHERE a heavy gradient or incline occurs upon a railway, necessitating the frequent and severe use of brakes to prevent too rapid descents, pieces of metal of a peculiar form, resembling the leaves of ferns, have frequently been found alongside the rails. A close examination of the specimens will satisfy the observer: (1) That, though differing in size and color, they have all the same origin and the same cause. (2) That being found on steep inclines only, they are probably due in some way to the

action of the brakes of descending trains. (3) That being —as will hereafter be shown—of steel, they must have come from the tires or rails and not from the brake blocks. (4) That in assuming their present form they have undergone considerable pressure, and at a temperature higher than ordinary.

It is the purpose of the present paper to consider and determine, if possible, how these specimens have been produced, and how far their existence has significance, either practically, as an element of destruction or danger on railways, or scientifically, as indicating what may happen when the power of metals to resist pressure or abrasion has been exceeded. By favor of Sir Lowthian Bell, who has taken an interest in the matter, I have obtained from Mr. R. Routledge, Chemical Analyst at the Northeastern Railway laboratory, Gateshead, an analysis of some of the specimens. He found them to contain the elements—see column No. 1—in the following table:

		Specimens.	Tires.			Rails.			Greatest resemblance to
Column No.		1	2	3	4	5	6	7	8
			from	to.	Average.	from.	to.	Average.	
Phosphorus....	(P)	.06	.04	.05	.045	.03	.07	.05	Rails.
Sulphur........	(S)	.07	.01	.09	.062	.04	.14	.07	Rails.
Carbon.........	(C)	.57	.24	.63	.486	.35	.60	.475	Tires.
Silicon..........	(Si)	.09	.16	.33	.274	.04	.10	.07	Rails.
Manganese.....	(Mn)	.79	.21	.52	.390	.80	1.00	.90	Rails.
Tin	(Sn)	.07	—	—	—	—	—	—	—
Iron............	(Fe)	98.35	—	—	98.742	—	—	98.435	Rails.
Total......		100.00			100.00			100.00	

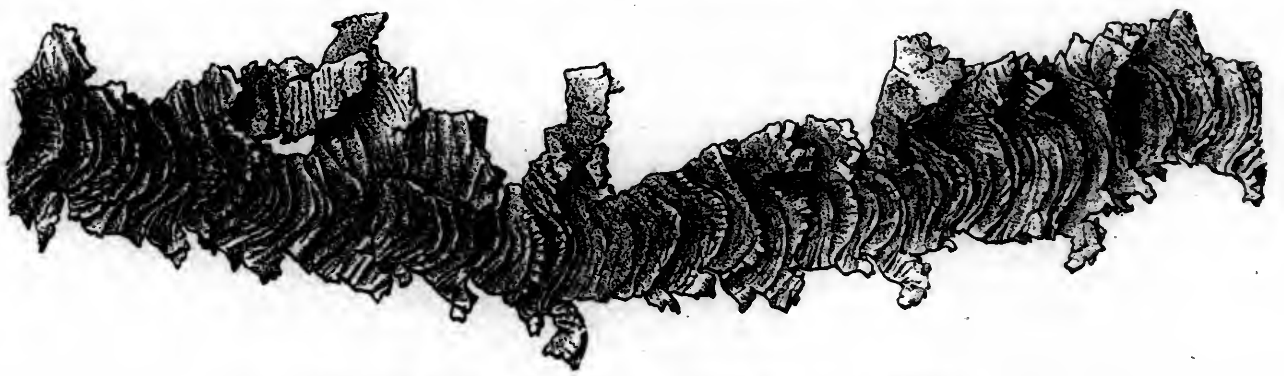
Mr. Routledge has also been good enough to give me typical analysis of tires and rails at present in use on the Northeastern Railway—see columns Nos. 2 to 7 inclusive.

The railway official who—as far as I know—first called attention to the pieces on the line, and who studied them at the time and place of formation, says: "I beg to state that the pieces of iron found near the rails leave the wheels whilst the train is in motion, and the wheels are skidding. Therefore, you will perceive it would be difficult to determine which wheels they come off." Again, he describes them as "pieces of iron, picked up on the incline, that have left the wheels by abrasion with the rail."

Mr. Charles Markham, of Staveley, to whom I am indebted for information and assistance, says: "I am certainly under the impression that the pieces are rubbed off the tires, but the matter has not been, as far as I know, investigated by any competent authority. My attention was drawn to the subject some four or five years ago, in consequence of a signalman having collected a number of specimens in his box, at the foot of an incline. For many years I had a good deal to do with the working of the Likey incline, near Bromsgrove. This appeared to me a place where there would be plenty of them. I believe that wherever there are inclined planes, and brakes are used, similar specimens could be obtained."

One of our most experienced locomotive superintendents, whose opinion I asked upon these specimens, has kindly given it as follows: He says, "Some years ago I collected specimens of the abraded iron and steel cuttings, which had evidently been caused by skidding of wheels while passing over curves on falling gradients. At that time we came to the conclusion that these cuttings came from the tires of goods brake vans, while going down inclines with the brake fully on. The goods guards have brake vans weighing 10 tons, and have the power by their own brakes to skid the wheels should they find it necessary. The specimens consisted of both iron and steel, and might come from either rail or tire; but I am inclined to the opinion that, except in case of worn rails, they for the most part come from the tires. They are, in my opinion, torn off when the wheels are skidded, and while passing round sharp curves when the rails are somewhat worn. With continuous brakes, we do not skid the wheels, except when the drivers keep the full power on to the end of the stop, and then they may skid, just before the train is brought to a stand only. We find that tires which frequently pass over inclines wear out only in proportion to the duration of time the brake is applied, and to the number of such applications of the brake. During the applications of the brake, more especially if the wheels are skidded, sharp curves and crossings are greater factors in the destruction of tires than inclines where brakes are applied without skidding. Tires wear into flat places, indicating skidding, but only in the case of guards' brake vans and of wagon tires when spragged, and which work frequently over inclines where spragging is necessary."

The opinions I have quoted, although, perhaps, not in all cases very decided, seem to incline to the belief that the specimens have been torn from the *tires* rather than from the *rails*. Mr. Routledge, however, whose opinion I invited, takes a somewhat different view. He thinks that they come from the *rails* and *not* from the *tires*.



STEEL SCALE PRODUCED BY SKIDDING RAILROAD WHEELS.

An examination of column No. 8, which shows whether the proportion of each element found in the specimens inclines most toward what is usual in rails or in tires, favors this view. It will be seen that in every case except that of the carbon, where the difference is very slight, the analysis agrees most nearly with that of rails. As compared with rails, the tires analyzed seem to be characterized by high silicon and low manganese, which is not the case with the specimens. The presence of a small quantity of tin is somewhat remarkable; but Mr. Routledge informs me that that element occasionally occurs in pig-iron.

Inasmuch, however, as the blows or charges of steel are often run indiscriminately into ingots for rails or for tires, and, as it cannot be stated certainly what was the composition of the identical tires and rails concerned in forming the specimens analyzed, it is scarcely prudent to found any strong argument upon these analyses.

Such shavings as these, rubbed off from the surface of tires or of rails whenever a wheel is skidded, indicate, for the time being, very rapid destruction.

The lesson taught, or rather re-taught (for it has often been inculcated before), is that wheels should *never be skidded*. But, on the other hand, trains, whether passenger, goods or mineral, should always be retarded by braking a sufficient number of wheels to effect the desired ob ject with a pressure somewhat short of skidding. Skid-

ding wheels is indeed a barbarous and ineffectual attempt at retardation, whilst it is a most effectual cause of disintegration.

The specimens looked at from a scientific point of view, are interesting. Their color indicates that they have been formed at a high temperature, as they have clearly all been originally coated with magnetic oxide—Fe_3O_4. The comparatively large body of metal forming the rail, and its continual presentation of new surfaces during skidding, make it improbable that it could have reached any high temperature; whereas skidded wheels might easily present the same surface long enough to accumulate heat locally to a greater extent than could be, *pari passu*, dissipated by conduction.

The multitude of folds which appear in all the specimens, and the tendency to spread into various forms, seem to indicate that under the pressure to which they have been subjected the metal has "flowed" with great freedom.

Reviewing the evidence obtained so far, the writer inclines to accept the following conclusions, viz.: (1) That the pieces have come from the tires of skidded wheels, and not from the rails; (2) that they were produced at a sufficiently high temperature for the formation of magnetic oxide, *i. e.*, at a red heat; (3) that they were forced out from behind the skidded wheels—the folds being on the under side—until from their accumulated length and weight they fell off; (4) that the only way to avoid the destructive action which they indicate is to brake more wheels to an extent short of skidding.

Car-Heating in Massachusetts.

THE Railroad Commissioners of Massachusetts have issued a circular to the railroad companies of the State, in relation to car-heating, which is as follows;

Chapter 362 of the Acts of the present year is as follows:

SECTION 1. No passenger, mail or baggage car on any railroad in this Commonwealth shall be heated by any method of heating, or by any furnace or heater, unless such method or the use of such furnace or heater shall first have been approved in writing by the Board of Railroad Commissioners: provided, however, that in no event shall a common stove be allowed in any such car; and provided also, that any railroad corporation may, with the permission of said Board, make such experiments in their passenger cars as said Board may deem proper.

SECTION 2. Any railroad corporation violating any of the provisions of the preceding section shall forfeit a sum not exceeding $500.

SECTION 3. This Act shall take effect upon its passage.

This Act became a law on the 6th day of June last, and, on the 25th day of June, this Board issued a circular to the railroads asking for a statement as to their respective outfits for heating cars. These statements were furnished as promptly as could have been expected, and yet more than a month elapsed before full returns from the roads were received.

In the summer time it is impossible to make satisfactory practical tests of heating apparatus, and yet it is necessary for the Board, without delay, to approve in writing of some methods of heating, of some furnaces or heaters, so that the corporations may not be obliged to choose between heating the cars illegally and suffering them to go unheated.

An examination made last winter of the practical working of the Emerson, Martin and Sewell systems satisfied the Board that the use of steam from the locomotive promises better results in the four great elements, of safety, comfort, simplicity and economy, than any other device known, and the Board hereby approves of the method of heating cars by steam from the locomotive at low-pressure, and recommends that each railroad should at once prepare to make practical tests of the system during the coming winter.

While, however, the results already obtained by the various inventors using this system are remarkably satisfactory, and while the Board believes that this system will eventually largely supersede the use of separate heaters, it nevertheless realizes that further improvements are probable, and that difficulties, especially with reference to local trains, are still unsolved. It is worthy of note in this connection that the President of the Connecticut River Railroad, in response to the above mentioned circular of this Board, dated June 25th, states that:

Seventeen of our cars are heated by the Emerson Car-Heating System, and are used only on our local trains. * * * This system we have found to be very simple in its construction and management, and less expensive than heating cars by stoves.

The importance of securing uniformity of steam-pipe couplings and of providing in many cases for the heating of a car when not attached to a locomotive are obvious.

The separate heater cannot, at present, be wholly dispensed with, nor would it be possible for the railroads to make so radical a change before cold weather sets in. The cars must be heated. The chill of the unheated car would probably kill more people than the flames from broken heaters. Death would ensue not so suddenly but none the less surely.

Chapter 54 of the Acts of the year 1882 reads as follows:

Every drawing-room or sleeping car, passenger, baggage, mail and express car, owned or regularly used on any railroad in this Commonwealth, in which heating apparatus may be placed, shall be provided with such safeguards for protection against fire as may be approved in writing by the Board of Railroad Commissioners. Any corporation violating the provisions of this section shall forfeit for each offense $300. The provisions of this section shall take effect the first day of November, 1882.

Since the passage of the foregoing act the use of heating apparatus not provided with safeguards approved by the Board in writing has been illegal. From time to time, during the past five years, applications for such approval have been made, and in some cases they have been granted and in others refused. The Board does not withdraw the approvals heretofore granted under the Act of 1882 aforesaid, and hereby, for the present, renews such approvals, provided, however, that in no event shall a common stove be allowed in any passenger, mail or baggage car, the use of such stoves being expressly prohibited by the aforesaid Act of the present year.

In selecting heating apparatus to take the place of the "common stove," the Board recommends the adoption of the system of heating by steam from the locomotive, or at least of such approved heating apparatus as can be used in connection with or readily converted into such system.

ACCIDENTS ON BRITISH RAILROADS.

THE number of accidents reported on British railroads in the year 1886, as given in the Board of Trade returns, was given in the JOURNAL for July, page 309; briefly repeated, that statement gave a total of 119 collisions, 1,772 derailments and 25 other accidents, or 1,916 accidents in all. The fuller report, which has now appeared, shows that of these accidents 62 in all have been inquired into or investigated by the Inspectors of the Board.

The remarks of the Railway Department of the Board on the results of these investigations are as follows:

1.—Defects of Permanent Way: Seven investigated accidents occurred in this class, resulting in the death of 6 passengers and injury to 37 passengers and 4 servants of companies. One of the accidents was attributed to the want of proper super-elevation of the rail at the junction of a left-hand with a right-hand curve; one to distortion of the rails in a curve by excessive sun heat, combined with the want of proper expansion intervals between the rail-joints, to an insufficiently ballasted road and to a speed too high for the condition of the road; two to obstructions getting upon the rails; one to the line not being properly ballasted; and one to the failure of a driver of a train to observe the signal given him by the plate-layers at work relaying the track. In one case, had

there been an automatic brake on the train, the guard might have applied it and stopped the train in time to have prevented the accident; another accident was in some measure attributed to goods-wagons being placed in front of passenger-carriages in a mixed train.

2.—*Defects of Equipment:* Under this head 8 accidents were investigated, resulting in injury to 116 passengers and 4 servants of companies. One of the accidents was due to the breaking of the stay-rod of a van; one to the worn condition of the flange of a wheel under a wagon in a mixed train; two to the fracture of the axle of a wagon in a mixed train; one to oscillation of a van of a mixed train, due to the brasses not being of the best shape; one to the defective state of a wagon; and one to the fracture of the draw-bar of a wagon of a goods train.

3.—*Trains Entering Stations at too Great Speed:* Under this head 4 accidents were inquired into, by which 15 passengers and one servant of a company were injured. These four accidents were in each case due to the want of care of the driver. In two of these the driver might have stopped in time, had there been a continuous brake upon the train; in another, had the engine as well as the train been fitted with continuous-brake apparatus, the accident might have been avoided.

4.—*Collisions at Junctions:* Under this head 10 collisions were inquired into, by which 41 passengers and 13 company's servants were injured. Three of the collisions were due to the fault of signalmen; six were due to the engine-drivers not keeping a good look out for the signal; one was due to the mistake of a brakeman. In three instances the collisions were due to the want of block working, or to a defective system of block working; and in four instances the collisions might have been prevented had there been a good continuous brake upon the train.

5.—*Collisions within Fixed Signals at Stations:* Under this head 25 collisions were inquired into, by which 2 passengers and 1 servant of a company were killed, and 256 passengers and 30 servants were injured. Of these collisions the principal causes may be summarized as follows: Eight were mainly due to mistakes of signalmen in block working, arising from forgetfulness or want of care; two were due to the combined mistakes of signalmen and engine-drivers; six were mainly due to want of care on the part of engine-drivers in running their trains at too high a rate of speed, not having them under proper control, or not keeping a proper look out for signals. Some of these collisions occurred under very trying circumstances, in densely foggy weather or during snowstorms, which led to the breaking down of the telegraph wires and the suspension of block working. One serious collision was due to the bursting of a brake tube; one was due to the freezing of water in the vacuum brake pipes. In four instances had the trains been fitted with continuous brakes the collisions might have been avoided; in one instance the automatic action of the continuous brake was valuable in mitigating the effect of the collision; and in another the superiority of an automatic brake over a non-automatic brake was shown.

6.—*Butting Collisions:* Under this head one accident was inquired into, by which 1 servant of a company was killed and 5 hurt.

7.—*Accidents in consequence of Engines or Trains being wrongly turned into Sidings or otherwise through Facing Points:* Under this head 4 accidents were inquired into, by which 4 passengers were injured. Two of them were due to an accumulation of snow preventing the points from being accurately closed. One was due to the mistake of a signalman, lowering the wrong signal for the train to proceed; and one was due to a breach of the rules for block working.

8.—*Accidents on Inclines:* Under this head three accidents were inquired into, by which 29 passengers and 2 of the companies' servants were injured. Two accidents were due to the want of caution in coupling operations on steep gradients and the want of sufficient brake power on the carriages; one was due to the wagons of a mixed train becoming uncoupled on an incline.

9.—*Accidents to Servants of Railway Companies Generally:* There were 23 railway servants killed and 301 injured whilst employed in coupling and uncoupling of vehicles; 96 were killed and 867 injured whilst employed in various shunting operations; 18 were killed and 54 injured by being caught between vehicles; 10 were killed and 24 injured by falling between the train and platform; 87 were killed and 118 injured whilst working on the permanent way and sidings; and 81 were killed and 111 injured whilst walking, crossing or standing on the line on duty.

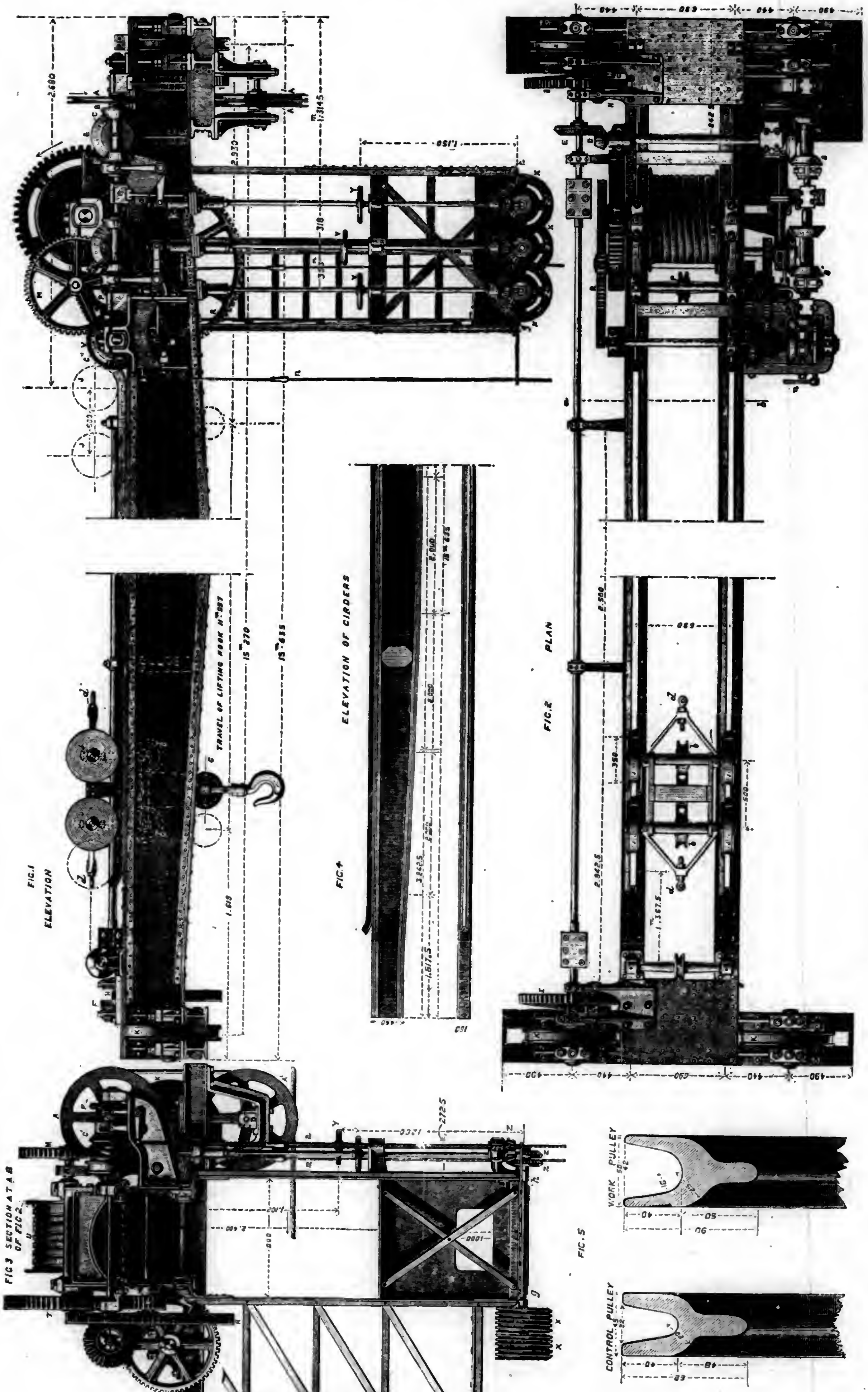
10.—*Accidents to Other Persons:* The accidents to persons passing over railways at level crossings show a serious increase, the numbers being 81 killed and 25 injured, against 58 killed and 21 injured in 1885. The number of trespassers were, however, only 205 killed and 91 injured, against 250 killed and 126 injured in 1885. The number of suicides were 80, against 55 of 1885. Accidents to trespassers and to persons crossing the railways at level crossings still continue to be quite as large as in former years, and though, no doubt, they are principally due to the want of caution on the part of the persons themselves, it is a question whether, if better gates and fences were provided and more stringent rules enforced, so great a loss of life need occur.

ABSOLUTE BLOCK AND INTERLOCKING SYSTEMS.

The amount of progress that has been made in the adoption of these systems may be found in the returns annually presented to Parliament. The proportion in which the signal and point levers had been interlocked on railways was 92 per cent. in England, 79 per cent. in Scotland, 52 per cent. in Ireland and 88 per cent. for the United Kingdom, being an increase of 1 per cent. during the year. The amount both of interlocking and block working on some railways in England and Scotland is, however, still short of what is necessary for safe working; whilst in Ireland it may be said that the progress made is far from satisfactory. It appears that since 1873, when 6,217 miles out of 16,082 miles then open were so worked, the block system has been largely extended, and that at the end of 1886 this system had been adopted on 14,639 miles out of 18,339 miles open for traffic. The progress made in England, Scotland and Ireland is as follows: In England and Wales, at the end of 1886, out of 12,946 miles of double and single lines open, 11,866 miles were worked upon the block system. In Scotland, out of 2,786 miles of double and single lines open, 2,249 miles were so worked. In Ireland, out of 2,607 miles of double and single lines open, 524 miles were so worked. The proportion of double and single lines worked on the block system being 91 per cent. in England, 80 per cent. in Scotland, and 20 per cent. in Ireland. The proportion of double lines, apart from single lines, worked on the block system was 97 per cent. in England and Wales, 97½ per cent. in Scotland and 29½ per cent. in Ireland; the total for the United Kingdom being 93 per cent.

GENERAL OBSERVATIONS.

The brake return laid before Parliament for the half-year ended December 30, 1886, shows a slight increase in the number of vehicles fitted with brakes complying with some or all of the conditions laid down in the circular of this department. The experience of the year under consideration adds to the evidence adducible in favor of a quickly acting continuous and automatic brake. The attention of the Board of Trade continues to be directed to the means employable for preventing accidents, not only to passengers but to the servants of companies. By the courtesy of the railway companies, an opportunity was given to the chief officers of the department of seeing most of the methods suggested with the view of facilitating the coupling and uncoupling of vehicles. On the whole the information given in this report shows that the working of the railways during the year 1886 bears a fair comparison with that of the preceding year. The comparative tables also show that the number of the inquiries in each of the last two years were fully 40 per cent. less than in the seven preceding years, and very much less than in several years preceding that period, when the traffic on railways and the length of railway open had not reached anything like the present amount. There has been no relaxation during the past year in the progress



50-FT. TRAVELING CRANE; PARIS, LYONS & MEDITERRANEAN RAILROAD SHOPS.

made for rendering railway working more safe by the extension of interlocking and absolute block systems over a larger railway mileage. The extension of these improvements, which is made from year to year, as well as the re-arrangement of stations, the heightening of platforms, the provision of foot bridges and subways, and of continuous footboards to carriages, all of which matters have met with considerable attention from the railway companies, will tend to lessen the number of accidents and add to the safety of the traveling public.

A FRENCH TRAVELING CRANE.

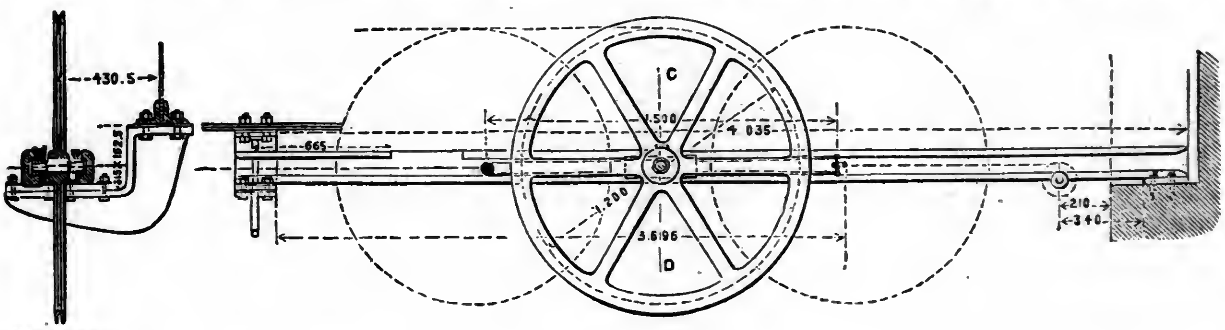
THE accompanying engravings show a traveling crane of 50 ft. span and a lifting capacity of 3 tons. which is in use in the boiler shop of the Paris, Lyons & Mediterranean Railroad at Oullens, France.

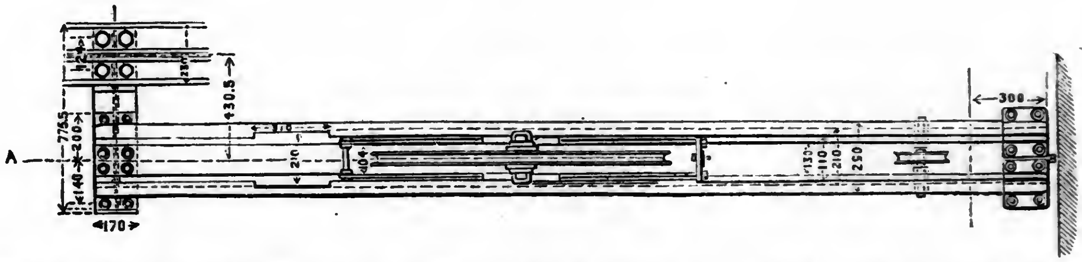
These cranes are worked by the shop engine by means of a fly-rope.

The same rope governs the four cranes of the central nave, one of which is of 20 tons power, the others being of 3 tons each. The engraving represents a crane of 3 tons power. It must be remembered, however, that the dimensions of the rope by which it is worked, and of which we are about to give some details, have been calculated in regard to the 20-ton crane. This rope is of 8 tton; it is 1 in. in diameter, of three twists, without any central cord. These twists are themselves composed of 25 strands each; they are twisted in a contrary direction to the rope, and have 13 to 14 turns to the meter. Thus formed, the cable should weigh about 1 lb. per yard, and should have a breaking strength of about 2 tons. Before being adjusted, it is steeped in a mixture of 25 part of tallow to 10 of resin and submitted for 10 days to a tension of 100 kilos. When in work, it is again coated with 16 parts of tallow to 10 of resin, as occasion requires. The driving pulley of the rope is placed at one extremity of the factory. It is 4 ft. in diameter, and makes 319 turns per minute. At the other end of the factory, being a distance of about 170 meters, the rope returns over another pulley of the same dimensions as shown by the engraving. Fig. 5 represents the grooves of both the pulleys. The pulleys by which the rope sets in motion the mechanism of the cranes have grooves of the first type; those which receive the cable on its return have grooves of the second type. All along its course, the cable is supported by brass rollers 6 in. in diameter, 12 meters apart. When acted on by the cable, these rollers revolve at the rate of 2,546 turns per minute. So great a speed requires that the rollers should have their centers of gravity rigorously placed in the axis of rotation, and that their axes should not be allowed to have too much play in their sockets. Taking the lineal speed of the cable to be 20 m. per second, as indicated, it has been calculated that the following speeds per minute are obtained for the divers movements of the crane:

	Cranes of 20 tons.	Cranes of 3 tons.
Speed in raising a weight..........	0 m. 610	8 m. 000
Speed in transporting a weight....................	9 m. 500	9 m. 220
Speed in transporting the crane from one end of the factory to the other......................	8 m. 965	9 m. 105

Description of traveling crane.—The frame is composed of two large iron girders and angle irons, resting at each extremity on two transverse double T-iron girders of 6¼ in. × 4¾ in. × 0.39 in. These latter are parallel with the ground; the rollers are placed between them, to which they are suspended by forked bolts. On the side where the rope runs, a third girder of double T-iron, parallel to the two first, and having the same transverse section, serves with them to sustain the pulleys A^1, and directs the rope over the driving pulley A. Each of the large girders is formed of an iron web of 0.39 in., which varies from 2 ft. deep in the middle to 16⅜ in. at the extremities, of two flat flanges 6¼ in. × ½ in. from one end to the other, and of four connecting angle irons 2⅜ in. × 2⅜ in. × 0.39 in. Each of the webs is formed of three plates, which are joined together by double-joint covers of 12 in. × 0.39 in. The plates of the lower flanges have their ends joined by joint-covers of 31.5 in. × 6¼ in. × ½ in. Those of the upper ones have no joint-covers. Fig. 4 gives the longitudinal section of the large girders. Rails are fixed on the large girders, along which runs a four-wheeled wagon, *J J*, which carries the load. This is sustained by an iron chain of 0.6 in. fixed to the hook *a*, at one end of the crane, passes over the two pulleys *b*, attached to the wagon, and over the movable pulley *c*, and rolls up over the barrel of the windlass *U* at the extremity of the crane. This disposition is the same as that of the hand crane described in our April number; it enables the wagon to run from one end of the crane to the other without either raising or lowering the load. The wagon is moved by means of an endless iron chain of 11 mm., the ends of which are fixed to the two ring bolts *d d* of the wagon, rolling over the pulley *f f* at one part, and over the nut *P* at another.





Working Mechanism.—The fly rope enters the crane by one of the pulleys A^1, which it quits vertically over the pulley A, describing a half circle; after this it again descends over the second pulley A^1, by which it leaves the crane. The pulleys A^1 are simple return pulleys; the pulley A, on the contrary, drives the whole mechanism. It is keyed on to its shaft, which consequently turns continually while the cable is in motion; no other part of the mechanism is set in motion by this movement, unless it be previously arranged so as to effect one of the three actions, raising of the load, driving the

wagon on the crane or displacing the crane itself. The three mechanisms of movement are composed of conical pinions with smooth surfaces, which can at will be made closer or more distant from one another, and which work by friction. The mechanism for removing the crane is nearest to the starting pulley. The two conical pinions *B B* are connected by a sleeve and controlled by one hand wheel, one or other of the pinions *B* being put in contact with the pinion *C*, which is driven in one direction or another, according to which pinion it has been brought in contact with. The displacement of the movable handle is effected by means of one of the hand wheels *Y*, which is worked from the platform *g h* suspended from the crane. This hand wheel is fixed to a rod, the upper end of which is screwed, and which cannot be moved without driving back one of the two springs contained in the boxes *k* and *l*. The pinions are thus forced upon the wheel *C* with a spring pressure, and the movement is gradually brought about by a slowly increased friction. The springs used for the purpose are as follows: Diameter of the steel wire, 8.2 mm.; outer diameter of the spring, 60.2 mm,; number of spirals, 10; height of free spring, 210.5 mm.; initial height of fixed spring, 167 mm.; height of spring completely closed, 153 mm.; initial reaction of spring, 140 kilos.; reaction of spring completely closed, 185 kilos. Under these conditions the movements are easy and continuous, but care must be taken to avoid the pinions being splashed with oil. In order to do so, the backs of all the pinions have been furnished with covers of brass, and screens have been placed between them for their protection. The mechanism for transporting the load is similar to that already described. The mechanism for raising the load differs from the other two in that the pinion B^{11} carried by the principal shaft is collared to a fixed post, while the pinion C^{11}, approaches it by the action of the rod. Further, this rod produces no action except in the direction of raising the load. For in the descent it is sufficient to loosen the brake by pulling the rope *m* when the load is heavy. In a contrary case, the rope *n* must also be pulled, which draws nearer to the pinion B^{11} a pinion *p* carried by the same shaft as the pinion C^{11}, and held generally apart from B^{11} by a buffer spring. The three fly-wheels *Y* and the ropes *m* and *m* are conveniently united in the hand of the conductor, who is placed upon the platform *g h*, and from this elevated position easily follows and conducts the manœuvres below him. In the engraving a system of notched pinions *Z Z* will be observed, and the pulleys for chains *X* placed below the platform *g h*, and commanding the three working rods. This system was invented in order to be able to work the crane from the ground floor of the factory in case of need by means of pendent chains. But experience has proved that it is always best to work it from above on the platform *g h*.

Lifting movement.—The pinion B^{11} governs the ascension movement by means of the smooth pinion C^{11} of the cogged pinion *Q* gearing with the wheel *R*, and of the cogged pinion *S* gearing with the wheel *T*, which is mounted upon the axis of the barrel *U*. The diameters of the governing pulley *A*, of the barrel *U* and of the pinions and intermediary wheels are as follows: Driving pulley *A*, 680 mm.;, smooth pinion B^1, 186.6 mm.; smooth pinion C^1, 280 mm.; cogged pinion *Q*, 63.15 mm., cogged wheel *R*, 1,200 mm.; cogged pinion *S*, 159 mm.; cogged wheel *T*, 1,035 mm.; barrel *U*, 650 mm. The result is that the relation between the course pursued by the cable passing over the pulley *A* and by the load is,

$$\frac{680 \times 280 \times 1200 \times 1035 \times 2}{186.6 \times 63.15 \times 159.2 \times 650} = 388.$$

The shaft on which the pinions *C* and *Q* are keyed carries a counterpoise brake and an automatic tightening brake of the Bourgougnon system, in connection with the hand crane of 8.80 mm. span. The diameter of the pulley of the brake *V* is 360 mm.

Traversing the Wagon J J.—The pinion B^1 causes the traversing of the wagon by means of the smooth pinion C^1 of the cogged pinion *L*, which gears into the wheel *M*, and of the cogged pinion *N*, which gears into the wheel *O* mounted on the axis of the nut *P*. The diameters of the governing pulley *A*, of the nut *P* and of the pinions and intermediary wheels are as follows: Governing pulley *A*, 680 mm.; smooth pinion B^1, 186.6 mm.; smooth pinion C^1, 280 mm.; cogged pinion *L*, 85.73 mm.; cogged wheel *M*, 700 mm.; cogged pinion *N*, 150 mm.; cogged wheel *O*, 375 mm.; nut *P*, 160 mm. The relation between the course pursued by the cable, passing over the pulley *A*, and by the wagon is:

$$\frac{680 \times 280 \times 700 \times 375}{186.6 \times 85.73 \times 150 \times 160} = 130.2$$

Traversing the crane.—The pinion *B* causes the traverse of the crane by means of the smooth pinion *C* of the cogged pinion *D*, which gears into the conical wheel *E*; of the two pinions *F*, which gear into the two wheels *G*; and of the two pinions *H*, which gear into the two wheels *I*, carried by the axis of the rollers *K*. The diameters of the driving pulley *A*, of the rollers *K*, and of the pinions and intermediary wheels are as follows: Governing pulley *A*, 680 mm.; smooth pulley *B*, 186.6 mm.; smooth pulley *C*, 280 mm.; cogged pinion *D*, 100 mm.; cogged wheel *E*, 300 mm.; cogged pinions *F*, 71.46 mm.; cogged wheels *G*, 250 mm.; cogged pinions *H*, 87 mm.; cogged wheels *I*, 695 mm.; rollers *K*, 650 mm. The relation between the course pursued by the cable, passing over the pulley *A*, and by the crane is:

$$\frac{680 \times 280 \times 300 \times 250 \times 693}{186.6 \times 100 \times 71.46 \times 87 \times 650} = 131.$$

Weight.—The total weight of a crane of the type we have just described is about 10 tons. The load under which these machines have been tested is 6 tons. This is double the normal weight they are called upon to raise in ordinary service. The *Portfeuille Economique des Machines*, from which we gather our information, says they have borne this test in the most satisfactory manner.

The dimension given in the cuts are in meters and millimeters.

The Velocity and Force of a Tornado.

[Abstract of paper read before the American Association for the Advancement of Science, at the New York meeting, by by C. Leo Mees.]

AFTER the tornado at Washington Court House, Ohio, September 16, 1885, it was noticed that in many places in the track of the tornado straws of timothy from 2 to 3 in. long were driven into bark and boards, penetrating to a depth of from 0.05 to 0.10 in. so firmly that they would break off if any attempt were made to pull them out. This could only have been effected by the force of the wind imparting to the straws a sufficient velocity to penetrate these hard substances. This explanation was so unsatisfactory to many, who sought to explain this curious phenomenon by making it depend upon various electrical forces and the like, that the author was led to attempt to produce similar effects by imparting a sufficient velocity to straws by means of an air-current, with the double purpose of proving that the phenomenon could be reproduced in this way, and of determining the minimum wind-velocity which must have been attained.

Hitherto no direct measurements of the velocity of the wind in a tornado had been made. The estimated velocities, ranging from 200 to 600 miles per hour, deduced theoretically from the probable difference in the height of the barometric column in the vortex and in the external atmosphere, must be regarded as merely approximations, because, to our knowledge, there have been no barometric readings ever taken in the vortex of a tornado.

After trial of various methods, it was found that by projecting straws from an air-gun of the air-chamber type, the phenomenon could be perfectly reproduced. A dozen or 20 straws were placed in the barrel of the gun without wad or packing and driven out by a puff of air. The velocity of the straws was directly measured by the method suggested by Professor Mayer for rifle balls in the *Proceedings* of the National Academy. The results were somewhat surprising. A velocity of 130 miles per

hour caused the straws to just stick in the board toward which they were fired. A velocity of 150 miles caused a penetration of about 0.0325 in. (about $\frac{1}{32}$ in.) in pine wood, while at 175 to 180 miles the penetration was 0.05 in. A velocity of 200 miles per hour caused the straws—or nearly all of them—to shatter.

It appears from these results that the minimum velocity of the wind in the tornado was from 140 to 175 miles per hour.

The Engineering Feature of the Nicaragua Ship Canal.

[Abstract of paper read before the American Association for the Advancement of Science, at the New York meeting, by Civil Engineer R. E. Peary, U. S. N.]

THE Nicaragua Canal is known by name, probably, to a majority of persons in this country; but the revised route, the enlarged capacity and the new features presented as the result of the last survey, made two years ago by the United States Government expedition in charge of Civil Engineer Menocal, U. S. N., are not so well known, and of them I will speak. The distance from ocean to ocean by the proposed route is 169.8 miles. Of this distance, however, only 40.3 miles are actual canal, the other 129.5 miles being free navigation through Lake Nicaragua, the Rio San Juan and the valley of the San Francisco. Beginning at the port of Brito on the Pacific side, the canal ascends the valley of the Rio Grande by four locks, and cutting through the low divide enters Lake Nicaragua 17.27 miles from Brito, at an elevation of 110 ft. above the sea. The route then extends across the lake, which is 40 miles wide and over 90 miles long, to its outlet into the Rio San Juan, a distance of 56½ miles. Then down the broad, deep reaches of the majestic San Juan to the dam, 64 miles from the lake. This dam, 1,255 ft. long and 52 ft. high, backs the water of the river the entire distance to the lake and makes it simply an extension of the lake. On the north bank of the river just above the dam, a short section of canal, less than two miles long, cuts through the hills into the Y-shaped valley of the Rio San Francisco lying north of the San Juan and separated from it by a range of hills. An embankment, 6,500 ft. long and 51 ft. high in the center, built across the stem of the Y, floods this valley to the level of the water above the dam and makes about 10 miles of lake navigation. At the eastern end of this lake commences the eastern division of this canal and pierces the divide by a cut 14,200 ft. long and averaging 149 ft. in depth. At the eastern end of this cut is the upper lock of the Atlantic flight, and from here the canal descends the valley of the Deseado by three locks to the sea level, and stretches across the lagoon region back of Greytown to the harbor 11½ miles distant. From the last lock to Greytown, the same as at Brito on the west side, the canal is enlarged, forming an extension of the harbor 11½ miles inland. The lake and the river must form a part of any and every canal route through Nicaragua, and the location as a whole is the result of Civil Engineer Menocal's complete and exhaustive personal knowledge of the entire country from ocean to ocean gained in the course of eight different surveys, extending over a period of 15 years, and supplemented by a conscientious study of all that has been done by others in that region.

Of the 40.3 miles of actual canal, about 27 miles will be excavation pure and simple, while the remaining 13 miles will be largely, if not entirely, excavated by dredges. With the convenient dumping ground for earth excavated, with a large portion of the rock from the summit cut utilized close at hand in the construction of the locks, the dam across the Rio Grande and in pitching the slopes of the canal, and a still larger quantity to be consumed in the construction of the breakwaters at Brito, the work in this section admits of the most economical execution. The divide cut from the basin of the San Francisco to the upper lock, 14,200 ft. in length and with an average depth of 149 ft., is, it is admitted, a very serious job; but with the neighboring streams offering water at a high head for removing the surface earth by hydraulic mining, with a large plant of power drills worked by compressed air, from the same source, and the use of modern explosives to remove the rock, with a large proportion of the excavated rock to be used in the construction of the locks and the dam, and in pitching the slopes of the canal; and a still larger quantity utilized in the construction of the harbors at Greytown; with the laborers above the miasma and mosquitoes of the swamp and exposed to the pure breath of the trade winds, the work can be done without serious difficulty.

There are two features of this project which to many who have not made such structures a study cause a question of safety to arise; one is the dam, which at one stroke gives us 64 miles of river navigation, and the other is the embankment, which at a second stroke gives us over 8 miles of lake navigation and completely solves for that portion of the canal from the dam to the divide (13 miles) the important problem of protection from surface drainage, but neither of them are anything more than small affairs when compared with many others scattered about the world and serving much less important purposes than the ones under consideration, and beside the Quaker Bridge Dam they are pigmies. Right here at the Croton reservoir is a dam which is to-day standing twice the strain that either of them will ever be called upon to resist. The locks are to be magnificent structures of concrete, 850 ft. long, 80 ft. wide and 30 ft. deep, capable of containing any merchant vessel afloat, except the *Great Eastern* and possibly the *City of Rome*. The necessary machinery for moving the locks and culvert gates, for hauling the ships in and out of the locks, for electric lights and other purposes will be worked by hydraulic power furnished by the locks themselves.

In regard to the general question of locks the late Ashbel Welch and the late John G. Stevens are quoted at some length in favor of their use.

Much has been said about the harbors at the termini of the Nicaragua route, and neither time nor space will permit me to enter into the discussion here. It may be said, however, that there is no practical route for a canal across the American Isthmus that has good harbors, and it is believed that those at the termini of the Nicaragua Canal can be made first-class at less cost than those of any other route. There is nothing more difficult in the improvement of Brito Harbor than has been successfully accomplished at numerous French and English breakwater-protected ports and harbors, and the maintenance of the harbor of Greytown will be a much less serious job than is the maintenance of the Port Said entrance of Suez, with the enormous salt discharge of the Nile driven across its mouth by strong littoral currents.

Lake Nicaragua has a surface area of some 2,000 square miles and a drainage area of not less than 8,000 square miles, and the Rio San Juan, its only outlet, discharges at its lowest stage, near the close of the dry season, eight times the maximum supply required by the locks. An inexhaustible supply of the best building material, such as lime, natural cement, stone and timber, can be obtained on the line of the canal, and with an abundance of palm leaves for thatching, such temporary buildings as are required for the accommodation of the working force and the protection of property can be constructed at little more expense than that of handling the material.

At Suez, the traffic has been seriously delayed by the dimensions of the canal and the inadequate number of the turnouts. In the present project, not only have enlarged prisms been provided for, but larger basins are proposed at the extremities of the locks. These basins, the enlargement of the canal at each end, with the lake, the river and the San Francisco basin, will permit vessels to pass each other without delay at almost every point on the route. In 22.37 miles, or 57 per cent., of the canal in excavation the prism is large enough for vessels in transit to pass each other, and of a sectional area in excess of the maximum area in the Suez Canal; the remaining distance in which large vessels cannot conveniently pass each other is so divided that the longest is only 3.67 miles in length; that, with two exceptions, those short reaches of narrow canal are situated between the locks and can be traversed by any vessel in less time than is estimated for the passage

of a lock; consequently, unless a double system of locks be constructed, nothing will be gained by an enlargement of the prisms. In the lake and in the largest portion of the San Juan River vessels can travel almost as fast as at sea. In some sections of the river, and possibly in the basin of the San Francisco, although the channel is at all points deep and of considerable width, the speed may be somewhat checked by reason of the curves.

ESTIMATED TIME OF THROUGH TRANSIT BY STEAMER.

	H.	M.
38.98 miles of canal, at 5 miles an hour	7	48
8.51 miles in the San Francisco basin, 7 miles an hour.	1	14
64.54 miles in the San Juan River, at 8 miles an hour..	8	4
56.50 miles in the lake, at 10 miles an hour	5	39
Time allowed for passing seven locks, at 45 minutes each	5	15
Allow for detention in narrow cuts, etc	2	00
Total time	30	00

The experience of the Suez Canal shows that the actual time of transit is more likely to fall under than to exceed the above estimate. The traffic of the canal is limited by the time required to pass a lock, and on the basis of 45 minutes (above estimated) and allowing but one vessel to each lockage, the number of vessels that can pass through the canal in one day will be 32, or, in one year, 11,680; which, at the average net tonnage of vessels passing the Suez Canal, will give an annual traffic of 20,440,000 tons. This is on the basis that the navigation will not be stopped during the night. The estimate of the total cost of the canal is $64,043,699, which sum includes 25 per cent. for surveys, hospitals, etc., and contingencies. The completion of the canal will require six years, one for final location and five for active work of construction, and the probable traffic for 1892, the possible date of completion of the Nicaragua Canal, is 6,506,214 tons.

Railroads in Turkey.

(From the London *Engineer*.)

FOR a long time past it has seemed as if the mileage of railways within the Ottoman Empire was doomed to remain stationary. It was the more difficult to account for this stagnation, because it was well-known that wherever railroads had been carried out in that empire the district served had experienced very material improvement, and the lines themselves had proved fairly remunerative. There is no country, perhaps, that—to judge from the experience already gained—more demands railroad facilities, or has shown itself to be more appreciative of them, than does the Asiatic territory of Turkey. With the details of the proposed route to India by the Euphrates Valley we are all well acquainted, nor are there many to be found who dispute the arguments upon which its proposers base their advocacy of it. But from a variety of causes this great scheme experiences delay in its realization. We are therefore pleased to learn that, by an imperial Irade (decree) just published in the *Gazette* of Constantinople, privileges have been accorded to British financiers which will enable a first step to be made toward securing the benefits which that route was designed to obtain.

The Irade referred to concedes the privilege of constructing a railroad to Bagdad, and those who have studied the question of providing an alternative route to India through Ottoman territory to the head of the Persian Gulf, will recognize what material aid this concession will afford toward the full ultimate execution of that scheme. A letter from Constantinople assures us that the new line, besides opening up many important and wealthy districts and towns throughout its course, will "bring India closer to England by some four or five days, thus providing a mail route shorter than either the Pacific or the Siberian" Whether it may eventually prove to be desirable that an Indian mail service should be organized by this new route, is a question upon which we do not feel prepared to enter. There may be, and certainly are, many considerations to be given to such a proposal which may not have occurred to the writer of the letter from which we quote; but the fact is incontestible that the advance of railroad communication between Europe and India as far as Bagdad, will revive the hopes of those who deem mail conveyance *via* the Asiatic provinces of Turkey to India to be perfectly feasible. But, apart from the prospect of obtaining a third alternative route to our Indian possessions which the late determination of the Sultan and his advisers has now opened out, we may regard with extreme satisfaction this new enterprise as certain to do much toward relieving the deadlock in prosperity which has so long oppressed the fertile provinces of Asia Minor. These are understood to be among the most productive territories of the world; and yet it is a well-known fact that, year after year, the crops produced in them are allowed to rot upon the ground, owing to the impossibility of conveying them to a profitable market.

The evil this want entails is well illustrated by a single instance given in the letter from which we have above quoted. Its writer informs us that "a sum of not less than £3,000,000 is annually spent abroad in provisioning Constantinople in respect only to three articles of consumption—flour, butter and meat—when Anatolia is well capable of supplying the whole of Turkey in Europe with a large surplus for exportation." We are naturally glad to learn that it is to British enterprise that the removal of so heavy a disability is to be entrusted, the concession having been made to the present lessees of the Haidar-Pasha & Ismid Railroad. Those acting with them contemplate bringing in the line from Haidar-Pasha to Scutari, so as to offer a port at its northern terminus protected from wind and sea at all seasons. This part of the work is to be commenced forthwith. In connection with the whole scheme we learn that a very important decision as to the character to be given to the lines has been arrived at, and this has doubtless been largely based upon the ascertained results to experience of late years in India. The Military Council of the Sultan is said to have strongly advocated their construction upon a narrow gauge; but full survey and inquiry proved that, although this might be cheaper in first cost, mile by mile, than a broad gauge, it would entail, as on the present Adrianople Railroad, the traverse of nearly twice the actual distance to avoid physical difficulties. If to this fact—which is said to have been fully ascertained—be added the considerations as to weight, conveyance, etc., which are now inducing the change in many parts of India of established railroads in that country from the narrow gauge on which they were first constructed to a broader one, we can well approve the determination of the Sultan to face first cost rather than expose the system to consequences which might ultimately cause a large increase upon it.

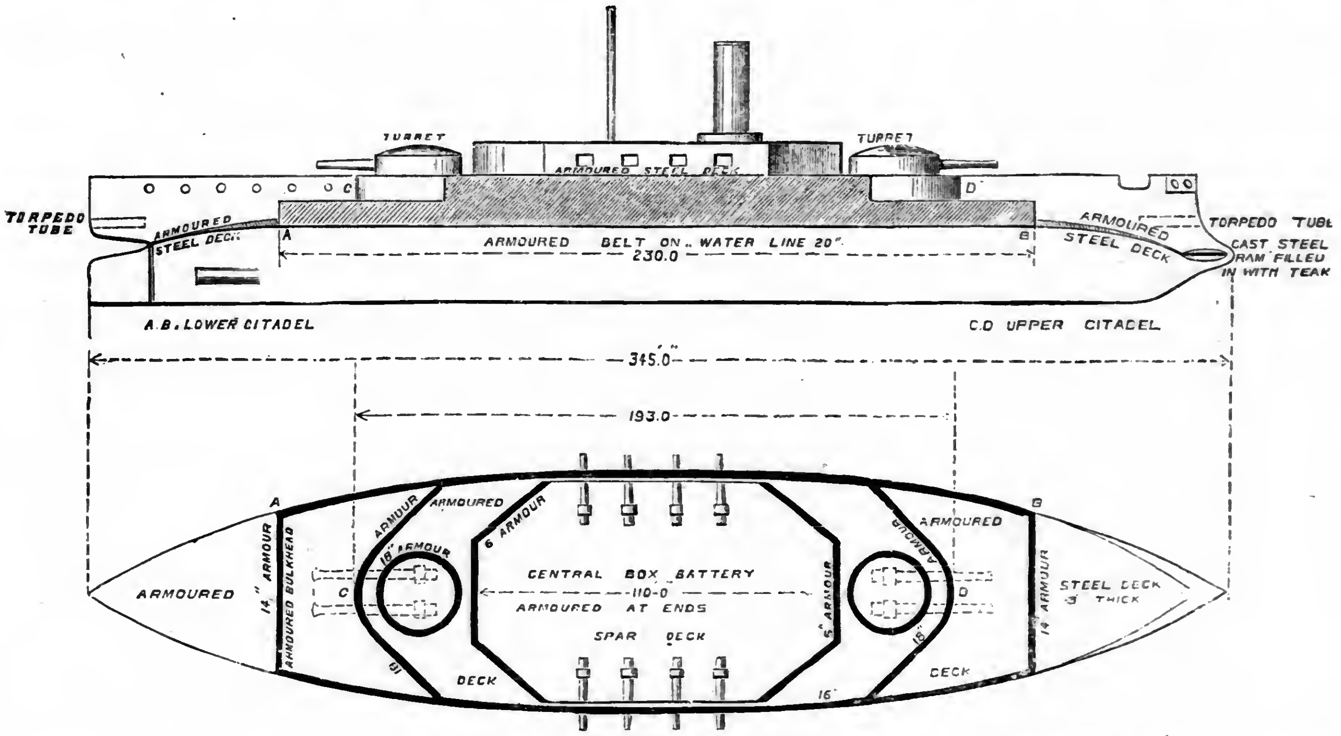
We may, we believe, see in the concession granted a strong desire on the part of the Government of Turkey to entrust the future of its railway extensions to British enterprise. It is well-known that for a long time foreign influences have been strongly competing in the endeavor to obtain this new opening for other nationalities. We have, of course, nothing to say on the political aspect of the Sultan's act. We may feel assured that, even before the new railroad reaches its terminus at Bagdad, British *entrepreneurs* will be active, with the object of extending it further toward the Persian Gulf. The route to India, therefore, that has so long been advocated, will probably by this independent concession find advancement from a quarter from which but little help was to have been expected. It may not fulfil all the desires of those who have struggled so persistently toward the realization of their designs, but it must contribute greatly toward ultimately obtaining the fulfilment of them.

The English War-Ship "Trafalgar."

(From the London *Engineer*.)

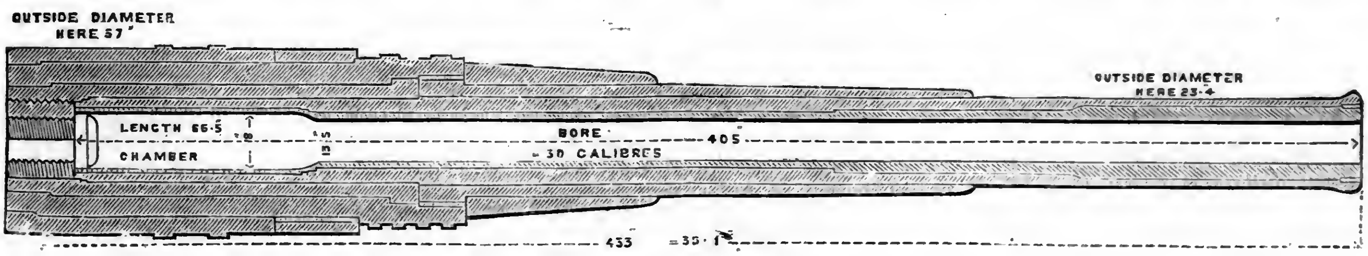
THE most powerful iron-clad afloat, so far as regards her thickness and weight of armor and displacement, H. M. S. *Trafalgar*, will be launched from Portsmouth Dockyard about September 20. The work of completing the vessel so as to be in readiness for this event is progressing with the utmost rapidity, and proceeds night and day un-

interruptedly, the hull being lighted throughout with electric lamps. This illumination is rendered necessary even at midday, as the ramification of water-tight compartments darkens the lowermost recesses of the ship completely. There are 27 entire bulkheads dividing the interior space into so many separate portions, and the decks again sub-divide these almost indefinitely. The Those on the sides taper, or are beveled off beneath the water-line to an edge of only 8 in. The teak is dressed and cut away on the surface so as to fit the plates precisely. The plates at the ends of the main citadel are secured by the bolts being passed through large holes left at intervals in the bed of the turret, otherwise they could not be worked in. Over the whole of the main or upper



THE ENGLISH IRONCLAD SHIP "TRAFALGAR."

accompanying illustration, which gives merely an approximate idea of this vast fighting machine, and is designed only to show the position of the several citadels, 3-in. steel decks and armored bulkheads, should be studied in order to understand the modifications which have been made in the two iron-clads of most recent type —the *Nile*, now building at Pembroke, and the *Trafalgar*, which is the subject of the present paper, they being sister ships. The dimensions are: Length, 345 ft.; breadth, 73 ft.; displacement, 11,940 tons; indicated H. P., 12,000; draft, 27 ft. 6 in. The armor belt at citadel is a 3-in. steel deck; upon this is built a central-box battery for eight 5-in. breech-loading guns. The side walls of this are of light plates, but the ends are protected from raking fire by 6-in. armor and a backing of teak. Upon the spar deck covering this battery the boats will be stowed, and a number of machine guns and quick-firing guns will be mounted, the latter comprising eight 6-pounder Hotchkiss, and eleven 3-pounders of the same nature. The ends of the vessel are protected beneath the water-line by a steel deck 3 in. thick, extending from the 14 in. bulkheads before alluded to to the ram at one end



SECTION OF THE ENGLISH 67-TON BREECH-LOADING GUN.

the water line extends to a length of 230 ft. amidships, and is 20 in. thick at the center, tapering off slightly to the ends, where it encounters and combines with bulkheads of 14-in. armor, thus forming with them a sort of lower citadel, this being decked over with 3-in. steel so far as the ends of the main or upper citadel. The same 20-in. plates that form the walls of this lower portion are continued upward as the walls of the upper citadel, which is 193 ft. in length, but the thickness of the plates is reduced to 16 in. The parabolic ends or bulkheads of the upper citadel are protected with 18-in. armor, as are also the turrets which spring from within its angles. The armor, both of sides and bulkheads, is backed with about 18 in. to 20 in. of teak, and behind this again is a strong inner steel skin 2 in. thick. The plates are compound, having wrought-iron backs with a steel face. and to the sternpost at the other. Thus the vitals of the ship are completely protected by armor plates from end to end. The number of torpedo tubes will, we understand, be four, one in the bows, one astern and two diagonally from the broadside. The turrets will be revolved by hydraulic power.

Each turret will contain two 67-ton breech-loading steel guns, which will also be loaded and worked by hydraulic power, being on the disappearing system, hinged upon huge levers, which rise for firing within rectangular slots, and descend for the loading position beneath the armored deck. A section of one of the turret guns appears in an illustration. Its dimensions are as follows, they being a striking contrast to those of the 81-ton muzzle-loading guns of the *Inflexible*, the proportions being so singularly slender, and the length so very remarkable: Total length,

36 ft. 1 in. (433 in.); length of bore, 405 in.; diameter of bore of gun, 13.5 in.; diameter of powder chamber, 18 in.; length of powder chamber, 66.5 in.; capacity of powder chamber, 17,100 cubic inches; weight of gun, 67 tons: full charge, 520 lbs. prismatic brown powder; estimated muzzle velocity, 1,960 foot-seconds. It is entirely of forged steel, and the disposition of the breech-piece and of the covering hoops have been designed so as to break joints and cover every conceivable spot which might be a source of weakness. The guns for the *Trafalgar* are now in course of construction at the Royal Gun Factories, Woolwich.

The cost of the *Nile* and of the *Trafalgar* is a very serious item. It will exceed that of any other vessels building or afloat. The estimate for each is £920,000. The hull, £686,000; the engines, £97,000; and the guns and their mountings, £137,000. But it must be remembered that these two ships are constructed entirely of the finest steel, and that the disposition of the armor is far more extensive and effectual than that of the *Inflexible*, or ships of the *Admiral* class, which are only partially protected. The only weak point that appears to us to be indicated in the arrangement of the plates upon the *Trafalgar*, is the side wall of the central box battery. Although protected from raking fire, we cannot but think that a heavy broadside fire might soon silence the eight 5-in. guns contained in it. Perhaps, however, the extra weight involved might dangerously affect the stability or buoyancy of the ship, already charged with a most preponderating weight of armor. Doubtless this has been taken into consideration. One thing, however, is very certain, that the *Trafalgar* is never likely to prove structurally weak, as has been reported, we regret to learn, in the case of the *Conqueror*, which suffered severely when her 45-ton guns were fired last week. The framing of the new vessel is of giant strength. The wonder that occurs to one in gazing upon so huge a mass of metal as she appears at present is that she can ever float at all. We should have mentioned that the important steering gear and engines which work it, are well down near the sternpost and below the protecting steel 3-in. deck. The coal is, as in the case of the *Imperieuse* and later ships, so disposed as to add an increment of strength to the armor, being spread beneath the decks in extended bunkers.

THE NEW WAR SHIPS.

THE report of Captain F. M. Ramsay, U. S. N., commanding the new cruiser *Boston*, gives particulars of the sea trial of the engines of that ship, from which the following statements are made:

Duration of trial 10:45 A. M., to 4:45 P. M.; breeze light, from S. S. E.; draft of vessel forward, 14 ft. 9 in.; aft, 19 ft. 2 in.

Maximum collective H. P. developed by machinery during the trial was	4248.50 I. H. P.
Mean collective H. P. during the trial was	3779 82 "
Mean collective H. P., excluding cards Nos. 6 and 13, taken when steam was down, was	3883.20 "
Coal burned per square foot of grate surface	35.43 lbs.
Mean air pressure, forward fire-room	0.985 in.
After fire-room	1.008 "
Maximum I. H. P. per square foot of grate	12.75 "
Mean distance run per hour	13.8 knots.
Mean revolutions	68.35
Mean steam pressure	86. lbs.

The engines worked smoothly, without jar, and perfectly cool, with the exception of two main journals which warmed slightly. After low-pressure crank-pin heated slightly, due to the telescopic oiling tube carrying away before trial began. During later part of trial a higher number of revolutions was made, due probably to decrease of friction of the higher parts.

The *Boston* has not been docked since September 6, 1886, and the comparatively low speed, compared with the *Atlanta*, is due to foul bottom. The trial was continuous, no stop; and the boilers did not foam.

The maximum indicated horse-power shown above was made up as follows:

High-pressure cylinder	1,561.6
Forward low-pressure cylinder	1,102.9
After low-pressure cylinder	1,259 0
Total main engines	3,923.5
Engine pumps, blowers and miscellaneous machinery.	325.0
Total maximum I. H. P.	4,248 0

During the trial of the *Boston* all her spars and equipments for sea were on board, except eight guns, and she was entirely under the control of officers of the naval service. The trial was made in Long Island Sound, the sea being smooth and only a light breeze blowing; the vessel steered easily; the Sickles steam steerer working admirably throughout the trial. The machinery was never stopped or slowed from the time of leaving the Navy Yard at 7:15 A. M. until anchoring off Whitestone in the evening; the data embraced in the report was for 6 hours only, although the engines were in constant operation for nearly 12 hours, working most smoothly and without any undue heating. The reversing engines worked most satisfactorily, it being possible to reverse the engines from full speed ahead to full speed back in a few seconds. The boilers were operated in connection with an air-tight fire room, the pressure averaging about 1 in. of water The air was supplied by Sturtevant boilers and the temperature of the fire rooms was about 90 to 100 degrees. The steam-pressure did not materially vary from 90 pounds, although the men were entirely inexperienced with either a closed fire room or bituminous coals. The air and circulating pumps were worked separately from the main engines, as were the feed and bilge pumps, and also in addition to the main engines, the blowers for fire room, ventilating fans and electric-light machinery were in constant use.

The main engines, it is believed, will develop 4,000 H. P., when the firemen are well trained in their work. The fuel used was New River (West Virginia) coal.

The engines of the *Chicago* have had the usual preliminary dock trials, the results of which have not yet been officially reported.

VESSELS FOR HARBOR DEFENSE.

Work has begun on the completion of the double-turreted monitor *Miantonomoh* at the Brooklyn Navy Yard. It is said that there will be no cessation of work until the ship is ready for service.

The Board to consider the question of the best method of expending the appropriation made by Congress for rams or vessels for harbor defense, has held several meetings and received a number of plans, but has taken no action as yet.

OTHER NEW VESSELS AND GUNS.

The Board appointed to estimate the cost of building the new armored cruiser on the plans of the Barrow Shipbuilding Company, and also the battle-ship on the plans of the Navy Department, has submitted its report. It is understood that the Board will report that neither ship can be completed for $2,000,000, the amount appropriated by Congress. Further action on the part of that body may therefore be needed.

It is said that the armored cruiser will be built at the New York (Brooklyn) Navy Yard and the battle-ship at the Norfolk Yard.

The schedule of new tools needed at the New York and Norfolk yards has been made up, and bids will soon be called for.

Active work is going on in equipping and preparing the new shops at the Washington Navy Yard for the assembling and finishing of steel guns of large size. The machinery includes very heavy lathes and also heavy cranes for handling the large guns and heavy masses of steel.

The 94 Hotchkiss guns ordered by the Navy Department are being built by the Pratt & Whitney Company in Hartford, Conn., under the supervision of Mr. E. W. Very, Agent of the Hotchkiss Company.

At the Navy Department, September 20, proposals were opened for cast-steel guns. These were the bids received under the advertisement of the Secretary, of June 23, extended July 20. This called for proposals "for the purchase and completion of three steel-cast, rough-bored and turned, 6-inch, high-power rifle cannon of domestic manufacture, one of which shall be of Bessemer steel, one of open-hearth steel and one of crucible steel." The Pittsburgh Steel Casting Company bid for the Bessemer gun, rough-bored and turned, at $3,300. The Standard Steel Casting Company, Thurlow, Pa., bid for the open-hearth gun, rough-bored and turned, at $5,300. These two were all the bids received. A condition of the contract is that no casting shall be paid for until the gun shall have been completed and successfully stood the statutory test.

THE DYNAMITE GUN.

A trial was made, Sept. 15, at Fort Lafayette, New York Harbor, of the pneumatic dynamite gun invented by Lieut. Zalinski. The condemned Coast Survey schooner *Silliman* had been procured as a target and was anchored at a distance of 1,980 yards (1⅛ mile) from the fort. After firing two empty shells to get the range, the actual trial began, with shells loaded each with 55 lbs. of the explosive. The first shell struck near the vessel, exploded, and a jet of water arose in the air at least 60 ft. As it fell, it was seen that the *Silliman* had lost one of her masts, a stump of the once solid wood testifying to the vessel's bereavement. The wood-work of the *Silliman* was seriously injured, and there was considerable water on the deck and in the hold. The fittings in the cabin were thrown into horrible confusion, and the beginning of the end had come.

The fourth shot made a terrific noise as it exploded, and the spray this time was blackened with smoke and interlarded with spars and small pieces of wood. When this had fallen, one glance showed that the work had been done. The *Silliman* was no more. A mast stuck up in the water; the remainder of the vessel had sunk. Pieces floated around everywhere. The projectile struck directly under the middle of the hull and lifted it bodily from the water. The *Silliman's* water tank was carried from the hold up through the deck and rested on the top of the wreckage. The stump of the mainmast directly in front of it was smashed completely.

The trial was concluded by firing two more shots. The fifth shot struck the wreckage that was sticking up in the water and cleared away a large amount of débris, making a loud noise. The sixth shot was simply to show that the projectile could hit exactly the same spot it had previously touched. It would have struck the *Silliman* in the same place that the third shot struck if the ruined vessel had not drifted 20 yards down the bay. As it was it exploded under the water astern of the wreck.

The air pressure used by Lieutenant Zalinski in the first four shots was 600 lbs., but, though they were successful in their work, they fell slightly short of what he had calculated. In the last two shots he raised the pressure to 607 lbs., which would have sent the projectiles right into the center of the vessel. Every one of the projectiles would have landed on the deck of any ordinary sized vessel.

The trial was witnessed by a number of naval and army officers and some other invited guests. Three Zalinski guns will be mounted on a gunboat now building in Philadelphia, for which a special appropriation was made.

OLD SHIPS CONDEMNED.

The old war-ship *Tennessee* was sold at auction at the New York Yard, September 15, and brought $34,425. She is to be cut down and end her days usefully, if ingloriously, as a coal barge on Long Island Sound. When built in 1865, just at the close of the war, the *Tennessee* was known as the *Madawaska*. She made a short trip under that name to the West Indies, after which she took her present title. She is of 3,200 tonnage and carried a battery of sixteen 9-in. smooth-bore guns, four 8-in. breech-loading rifles and one 11-in. rifle gun.

Her first long cruise abroad was as flagship of the East India squadron. But for the greater part of her commissioned life the *Tennessee* served as flagship of the North Atlantic Squadron, having carried the pennants of Rear Admirals Wyman, Cooper, Jouett and Luce.

The Chinese Navy.

(From the London *Times*.)

THE five vessels under Admiral Lang's command, now about to leave Europe for China, are a formidable installment of the "bolts and bars" of the Chinese Empire, which the Marquis Tsêng on a historical occasion said must precede all internal reform in that country.

The fleet is composed of two ships built at Elswick, two at Stettin and a torpedo boat built by Yarrows. The two English vessels are the *Chih Yüan* and the *Ching Yüan*, and are of the swift protected cruiser class. They were designed by order of the Marquis Tsêng, by Mr. W. H. White, then naval constructor to Armstrong, Mitchell & Co., but their construction has been carried out mainly under the superintendence of Liu, Ta-jên, the present Chinese Minister. Their displacement is 2,300 tons; the length is 268 ft., breath 38 ft. and depth from the main deck to the keel molded 21 ft. The draft forward is 14 ft., and aft 16 ft.

Each vessel has two pairs of triple-expansion engines, by the eminent firm, Messrs. Humphrys, Tennant & Co. Both the engine and boiler rooms are divided into water-tight compartments by transverse and longitudinal bulkheads, and the machinery is so arranged that either boiler can work on either engine or on both, and the change necessary to effect this can be carried out while the vessel is in motion. The consequence of this intercommunication between each engine and each boiler is that the vessel can proceed so long as any single boiler and any single engine are uninjured.

In the four trial trips, two with and two against the tide, with all their weights, armament and Chinese crews on board, they attained an average speed of 18.536 knots.

The crews, it should be mentioned, have been lying in Newcastle for the past two months or more, and their orderly conduct has been the subject of encomium. They seem smart, sailorlike and well cared for, and they apparently have the sailor's capacity of finding friends everywhere.

The material of the vessels is steel; there are two decks, the lower one being of the turtle-back description, and consisting of 4-in. steel plates, rising in the middle above the waterline and inclined at the sides so as to dip some feet below it. The engines, magazines, rudderhead, steering gear and all the important parts of the vessel are contained below and are protected by this deck. The openings in the deck are encircled by cofferdams, protected by steel plates, inclined so as to deflect the shot. The bows are formed and strengthened for ramming purposes. Additional protection is given to the vessel by the method of carrying the coals.

Placed on the turtle deck and running parallel to the sides of the vessel for the greater part of its length is a partition, enclosing a space between itself and the side. This space is subdivided into a great number of water-tight compartments for the reception of coal or patent fuel. An additional protection of a layer of coal about 8 ft. in thickness all round is thus given to the vessels. The bunker accommodation is 450 tons. Both ships have double bottoms, which it is unusual to find in vessels of this size, although their advantages to all ships, and more especially to war vessels, are obvious. The space between the two bottoms is divided into numerous water-tight compartments.

The armament consists of three 21-centimeter Krupp guns, two 6-in. Armstrongs, eight 6-pounder, rapid-firing Hotchkiss guns and six Gatlings. Of the Krupps two, which are placed in the bows, are mounted on Vavasseur carriages, on revolving platforms, protected by splinter-proof shields, and one, which is in the stern, is also placed on a Vavasseur carriage, revolving on a center pivot. In both cases the guns are moved by means of hydraulic machinery. The Armstrongs likewise move on center-

pivot Vavasseur carriages, and are placed on sponsons at the side of the vessel so as to allow of the training of the guns over a very large arc, about 160 degrees. These likewise are protected by 2-in. steel-plate splinter-proof shields.

The torpedo armament consists of four above-water torpedo guns—one fixed in the bow, firing right ahead, one right astern, and two training guns are fixed in each broadside forward.

There are two electric search lights for each vessel, of a nominal power of 25,000 candles, while the cabins and rest of the ship are lighted with incandescent lamps.

Each has two mainmasts, with military tops, four yards, fore and aft sails. Each has likewise a conning tower of 3-in. steel plates, from which the working of the ship's guns and torpedoes can be directed. An important addition is an armor-plated tower for the protection of the signalman, which was suggested by Admiral Lang.

The guns are provided with converging fire apparatus, so that they can be fired singly or simultaneously. The steering gear is hand and hydraulic. The equipment is exceedingly ample in every respect and has rarely, if ever, been equalled by that of any ship built in this country. Lord Armstrong and Captain Noble have put out all their energies in their respective spheres to make these vessels perfect as far as human skill and labor can perfect them.

The torpedo boat, as has been mentioned, was built by Yarrows, under a contract with Messrs. John Birch & Co., of Liverpool, and it is said to be the fastest of its size that has ever been launched. It has reached the great speed of about 28 miles an hour. It is armed with two fixed 14-in. torpedo guns in the bows and one 14-in. training gun on deck, abaft the funnel. It is also supplied with a powerful armament of Hotchkiss and Gatling guns and a strong electric light so arranged as to be worked either from the conning tower or from the deck, where it can be moved from side to side by means of rails. The light is also interchangeable in the conning tower with a Hotchkiss gun.

The two vessels built in Stettin by the Vulcan Shipbuilding Company, are of the class of armored cruisers. Their speed is under 16 knots. They are armed with two 21-centimeter Krupp guns in the bows, mounted *en barbette* and encircled by an armor-plated breastwork. These have also two 6-in. Krupps, so that, although larger than the Armstrong vessels, they have one 21-centimeter Krupp gun less than the latter. Their names are the *King Yüan* and the *Lai Yüan*, and their details were frequently altered during the course of construction.

This squadron of two armored cruisers, two swift protected cruisers and a torpedo boat is commanded by Admiral Lang, the officer to whom the Chinese Navy is indebted for the greater part of the efficiency it possesses. As he is an officer of the Royal Navy, in which he holds the rank of Captain, he is lent by the Admiralty to the Chinese Government, and nothing could demonstrate more clearly the desire of the British Government that China should have a strong and efficient navy than the loan of an officer so able, energetic and intelligent. Admiral Lang's value is well-known to the Chinese, and especially to Li Hung Chang, for, when he thought it his duty to resign his post on the outbreak of the Franco-Chinese war, and his place was taken by a German officer, he was welcomed back with open arms on the conlusion of peace.

Several retired officers of the Royal Navy have been employed to aid in navigating the squadron out to China, but each vessel is commanded by a Chinese officer who has passed through the Naval College at Greenwich and has served in one of Her Majesty's iron-clads. It should be added that the completeness of the armament and equipment of the squadron is largely due to the support and co-operation which the Ministers in London and Berlin received from Li Hung Chang, who, in his capacity of Vice-President and principal practical head of the new Board of Admiralty in Pekin, had naturally a preponderating influence in all questions connected with the expenditure on the ships.

Electric Light for the New Cruisers.

[Paper read before the National Electric Light Association by Lieutenant J. B. Murdock, U. S. N.]

THE question of how to best install the electric lights in the new men-of-war has been considered in detail, and it seemed advisable to bring the matter before the National Electric Light Association, that the manufacturers of the country might have the problem presented to their consideration in advance of the time when they would be asked to act upon it. In conversation with managers of various companies, it has been impressed on my mind that the peculiar conditions existing on shipboard are but imperfectly understood, and as a natural consequence they have not as yet been as satisfactorily met in this country as abroad. I am confident that American ingenuity and skill can fully meet our requirements, and hope that the number of dynamos, about 60, which will be needed for the vessels already authorized by Congress, may be considered as meriting the experiments necessary for their successful installation.

I am authorized to present in a general way the views of the Bureau of Ordnance of the Navy Department on the peculiar conditions to be met, and on the best method of meeting them.

In men-of-war the prime requirements of all kinds of apparatus are compactness and lightness. Neither of these is of any material consequence in electric-light installations on shore, and both are generally ignored. Attention has there been given mainly to the question of efficiency of conversion, and a glance at the advertising columns of any of the electrical journals shows that the maximum efficiency and best system of electric lighting is possessed by each of a dozen companies. Our conditions, so far as the dynamo is concerned, may be summarized as wishing the greatest electrical output for a given weight and bulk, and although at first thought this may seem to be essentially the same thing as efficiency of conversion, it is widely different.

The following figures of well-known American dynamos illustrate this point. The comparison is made on the basis of "watts of output per pound of dynamo." The weight, speed and electrical output have been obtained in general from the manufacturers, and are given, of course, only approximately. In this comparison it is, of course, necessary to consider also the sizes and the number of revolutions, the watts per pound increasing with large machines and high velocities. (Table I):

TABLE I.

DYNAMO.	Revolutions.	Watts in external circuit.	Watts per pound.
Edison, No. 20	800	50,000	6.0
Brush, H. 3	850	66,000	9.4
American, 50-Light	875	21,600	5.7
Westinghouse, No. 18	900	30,000	5.4
Hochhausen, No. 8	1,000	35,200	8.8
Mather, 500 Lights	1,050	35,250	7.4
Weston, 6 W. I	1,050	11,500	4.1
Brush, G. 4	1,050	28,300	9.3
American, 16-Light, Hie	1,075	6,480	4.8
Weston, 7 W I	11,000	20,125	6.5
Westinghouse, No. 12	11,000	18,000	4.0
Brush, F. 5	11,000	19,000	8.5
Thomson-Houston, H. I	11,500	25,600	6.1
Edison, No. 12	12,000	30,000	6.9
Hochhausen, No. 6	12,000	17,600	8.0
Thomson-Houston, E. I.	12,500	13,200	5.8
Mather, 400 Lights	13,000	28,100	7.0
Edison, No. 8	14,000	20,000	6.9
Thomson-Houston, C. I.	15,000	6,000	5.6

The next consideration is that of the connection of the dynamo to its engine. A starting point is afforded in the rule that belting should never be used on a sea-going vessel. Nothing so radically violates our condition of economy of space as the use of belting. When space is saved by the use of a short belt, the working conditions are comparatively unsatisfactory. Belts are liable to be thrown off by the sudden change of load to which our dynamos are subject, and become a source of danger to the attendants if the ship is rolling heavily. The adoption of friction gearing between engine and dynamos has been

suggested, and is probably practicable, but its durability on shipboard, when the motion of the vessel must cause working of the two shafts, may not be great. In the navies of Europe, the practice of direct connection is universal, the dynamo shaft being coupled to that of the engine. This calls, of course, for either a great reduction of the speed of the dynamo, or a corresponding increase of that of the engine. It is easy enough to procure an engine running 1,500 revolutions per minute, but it is a very different matter to find one which will govern satisfactorily at so high a speed. So far as I can ascertain there is no automatic engine manufactured in the United States capable of indicating 30 H. P. which is designed for a higher speed than 400. I have been informed, however, that some of the type now in the market could be modified so as to operate well at 500. I am not aware of any dynamo in the United States absorbing 30 H. P. which would yield its normal output at even the higher speed. It is much easier to reduce the speed of the dynamo, while preserving its electrical output, than to raise the speed of the engine. Admitting the desirability of direct connection on shipboard, the problem proposed is the best method of obtaining the same output, in watts per pound, at speeds below 500, that are now commonly obtained between 1,000 and 1,500.

The following figures of European dynamos, obtained in the same way as those already given for American machines and probably equally accurate, will show how this problem has been met abroad. (Table II):

TABLE II.

DYNAMO.	Revolutions.	Watts in external circuit.	Watts per pound.
Manchester, No. 6	350	9,000	3.6
Victoria, H. 3	350	36,000	9.7
Siemens & Halske	350	16,000	8.1
Edison-Hopkinson, 10 in L.	350	16,800	2.9
Manchester, No. 7	400	22,500	4.6
Victoria, F. 3	400	21,600	8.6
Siemens & Halske	400	20,000	10.2
Edison-Hopkinson, 15 in S.	420	39,600	3.4
Gramme, H. 2d 255	450	23,600	8.3
Elwell-Parker	450	50,000	5.6
Crompton, $\frac{40}{110\ J}$	460	45,100	6.7
Edison-Hopkinson, 8 in L.	525	15,400	3.3
Manchester, No. 5	525	6,500	4.7
Crompton, $\frac{22}{110\ J}$	550	24,750	6.0
Manchester, No. 6 A	550	25,000	6.75
Edison-Hopkinson, 10 in L.	550	25,200	4.4
Victoria, D 2 S	600	8,400	6.7
Gramme, H. I. c 200	600	14,000	6.4
Ganz	670	50,400	9.2
Crompton, $\frac{60}{110\ J}$	675	66,000	9.8
Goolden-Trotter	765	16,000	7.2

It is necessary to only refer incidentally to a few of the methods by which these results have been obtained. The principal are the elimination of all iron not needed for the magnetic circuit of the dynamo, and the adoption of a type in which the circuit furnishes a framework of necessary rigidity. The magnet core should be of the best wrought-iron, this single condition frequently reducing the weight 25 per cent., while preserving the output. Armatures of large diameter give high peripheral velocity at low speed, and this seems to recommend the Gramme ring, a large drum armature being cumbersome. The Gramme form has another advantage for ships' use, that it can be repaired or even re-wound with the facilities existing on shipboard, although I believe a Siemens winding has recently been perfected which admits of equal facility of repairs. The use of multipolar machines contributes to lightness, and the Siemens & Halske machine referred to in the preceding table has four field magnets inside a Gramme ring. Flattened ring armatures and multipolar magnets also give large output for the weight.

Every ship, aboard which the electric light is a necessity, should have two similar dynamos, that either may be used at will. At present, this precaution is not observed in the Navy. The lighting of the ships by incandescent lamps is under the control of the Bureau of Navigation, and the installation for this purpose consists of an ordinary plant of an engine driving a dynamo by belting. The electric search lights, two of which are furnished to each large vessel, are supplied by the Bureau of Ordnance, the installation for this purpose consisting of a Brotherhood engine driving two "C" Grammes connected direct on the same bed-plate. In case of accident, the incandescent dynamo will not work the search lights to advantage, nor will the Grammes operate the incandescent lights well. This is, of course, most unsatisfactory, and the need of the service is for a dynamo which will perform either work well, and, if necessary, both at once. Our search lights require about 50 volts and 50 ampères for ordinary work, the current being sometimes increased to 100. The lamp is operated by hand in order to fully utilize the radiation from the crater of the positive carbon. The hand lamp and Mangin projector are in use in nearly every navy in the world, for projecting a condensed beam of light to a distance. Automatic lamps do not admit of continuous adjustments as readily as the hand lamp, and are not so thoroughly under the control of the operator. In any search lights the arc may sometimes fail, and it is sometimes advisable to cut the lights out without notice. Large and sudden variations of load are thus liable to occur, and these should not affect the dynamo. It is unquestionable that incandescent lights can be worked from a series dynamo, and search lights operated by a shunt machine, but most of these proceedings are makeshifts. It is undeniable that both search lights and incandescent lights can be worked satisfactorily by a compound dynamo. I have been called upon to work all these kinds of dynamos for each purpose, and the compound dynamo works incandescent lights as well as the shunt machine and search lights better than does the series machine applied for the purpose. I have also worked 2 search lights and 50 incandescent lights simultaneously from one compound dynamo. Each search light had three-tenths of an ohm dead resistance in circuit to bring the difference of potential down to about 50 volts. There is nothing new in this, but I have so frequently been asked what advantage the compound dynamo possessed, that I have trespassed somewhat on the time of the Convention to give reasons for the opinion that all naval dynamos should be compound wound for a constant potential.

It is probable that many fine new vessels will require electric motors. Some of our gun carriages may be worked in this way, on account of the advantages that an electric motor offers in small weight and bulk, and in the important fact that it is so much easier to splice a broken main than to patch a leaky pipe when steam or compressed air is used for power. Electric motors will be useful for shell hoists and ammunition whips, reducing the number of men employed for these purposes. Here, also, light weight and compactness are absolutely essential, and nine-tenths of the motors in commercial use would be barred out as too heavy. A 10 H. P. motor, the largest we would probably use, should not weigh over 500 lbs.

The potential at which the main should be kept must be determined from the relative importance of the three uses to which our dynamos will be put. As we are not bothered by the question of long-distance transmission, we can well use a low potential for incandescent lights and motors, while search lights require only 50 volts, although it is advantageous with any dynamo to have a little dead resistance in the search-light circuit. For these reasons I think 70 volts is about the best point for a compromise. This is the voltage used in the French Navy, the English working at 80. If two search lights can be successfully worked in series, the potential at the dynamo might advantageously be raised to 110 or even 120 volts. Experiments have been made to test this point, but it is not decided as yet. Should there, however, be any material advantages secured in the working of either incandescent lights or motors by the use of a high potential, the search lights could be operated with sufficient resistance to give them their proper potential.

The same requirements of small bulk and weight must control in the choice of engines. The adoption of a compound dynamo throws extra responsibility on the engine, as without constant speed the advantages of the dynamo are not apparent. American automatic engines can easily

meet this demand, but most of them are too heavy, rigidity of frame being secured by the use of unnecessarily large masses of cast-iron. One hundred pounds weight per I. H. P., with 80 lbs. steam, is a liberal allowance. In many European engines steel and phosphor-bronze have been largely used to obtain lightness.

It may be interesting to compare a few well-known dynamos as to compactness, the comparison being made watts of output per square inch of floor-space. (Table III):

TABLE III.

Dynamo.	Revolutions.	Watts in external circuit.	Watts per sq. inch floor-space.
Manchester, No. 6	350	9,000	4.9
Edison-Hopkinson, 10 in L	350	16,800	6.0
Manchester, No. 7	400	22,500	6.0
Edison-Hopkinson, 15 in S	420	39,600	9.1
Crompton, $\frac{40}{110\ J}$	460	45,100	20.3
Edison-Hopkinson, 8 in L	525	15,400	6.5
Manchester, No. 5	525	6,500	4.6
Ganz	670	50,400	20.9
Crompton, $\frac{60}{110\ J}$	675	66,000	26.4
Edison, No. 20	800	50,000	8.8
Brush, H³	850	66,000	23.5
Westinghouse, No. 18	900	30,000	5.8
Hochhausen, No. 8	1,000	35,200	15.0
Mather, 500 Lt	1,050	35,250	8.5
Weston, 6 W. I	1,050	11,500	4.4
Brush, G⁴	1,050	28,300	17.7
Weston, 7 W. I	1,100	20,125	5.4
Westinghouse, No. 12	1,100	18,000	4.7
Brush, F. 5	1,100	19,000	15.3
Thomson-Houston, H. I	1,150	25,600	9.0
Edison, No. 12	1,200	30,000	7.7
Hochhausen, No. 6	1,200	17,600	13.3
Thomson-Houston, E. I	1 250	13,200	8.2
Mather, 400-Light	1,300	28,100	7.3
Edison, No. 8	1,400	20,000	6.0
Thomson-Houston, C. I	1,500	6,000	5.9

The preceding show a general average of about 40 lbs. dead weight of dynamo and engine for each 16-candle lamp, whether high or low-speed dynamos are used. In the following tables special attention has been paid to the manufacture of light and compact apparatus.

As illustrating the advantages of direct connection in economy of floor-space and also of weight when care is taken, I give a few statistics of ship installations in Tables IV and V (these tables will be found below, on this page).

It is noticeable abroad that, with the type of slow-speed dynamos established in the markets, the system of direct connection is adopted in many isolated plants on shore. The tendency throughout Europe is to reduce the speed of dynamos, preserving the electrical output by a careful study of details. Few recent machines built abroad are designed for higher speeds than 800, while an American company operating at and above 850 advertises slow speed as one of the advantages of its dynamos.

In this country the naval demand for slow-speed dynamos will be comparatively small, but if it serves to introduce the type into the market, I am satisfied from what has taken place in Europe that the system of direct connection will create a field for itself, as soon as the apparatus can be procured without the heavy expense attendant on special work. It recommends itself in any installation where either weight or floor-space is to be economized. I believe it can be successfully used and utilized in lighting railroad trains, especially if, in the near future, railroad companies have to furnish steam for heating purposes. Plants could be furnished small steamers and yachts, in which a common installation could not find room.

There are one or two other considerations governing ships' installations. The principal one is the absolute necessity of high insulation. The Bureau of Navigation has, in its recent contracts, called for an insulation-resistance of 1,000 megohms per nautical mile, after 24 hours' immersion in salt water.

TABLE IV.

	Plant.	Connection.	Total weight.	Floor-space.	Weight per 16c. lamps.	Sq. in. of floor-space per 16c. lamps.
	1 200 light Brush compound 1 8-in. Brotherhood	Direct.	5,500		27½	
Steam yacht *Restless.*	1 Arnold dynamo (30 lights) 1 Vertical engine	Friction.	600	6 sq. ft.	20	29
	1 Goolden-Trotter dynamo (75 lights) 1 Tower engine	Direct.	900	5¼	12	11
	1 Victoria dynamo (60 lights) 1 Brotherhood	Direct. 765 Revs.	800	4 5/16	13	11
Italian cruiser *Dugali.*	1 Parson's dynamo (150 lights) 1 Parson's steam turbine (3 plants like above.)	Direct. 9,000 Revs.	900	6¼	6	6

TABLE V.

	Plant.	Connection.	Total weight.	Floor-space.	Weight per 16c. lamps.	Sq. in. of floor-space per 16c. lamps.
U. S. Steamer *Chicago.*	2 Edison No. 8 (200 lights) 2 Armington & Sims	Belting.	16,000		40	
U. S. Steamer *Boston.*	1 Brush compound (150 lights) 1 Straight Line	Belting.	10,400		70	
U. S. Steamer *Atlanta.*	1 Weston, 7 W. I. (150 lights) 1 Armington & Sims	Belting.	6,500	105 sq. ft.	43	101
Steam yacht *Alva.*	1 Siemens compound (160 lights) 1 Willans's engine	Direct. 450 Revs.	6,700	27	43	24
French ironclad *Indomptable.*	2 plants each 1 multipolar Gramme (160 lights) 1 vertical compound engine	Direct. 350 Revs.	7,040	29	44	26
Torpedo Station.	1 Brush No. 7 special (100 lights) 1 Westinghouse	Direct. 700 Revs.	4,000	17	40	25
Torpedo Station.	1 Weston No. 8 special (270 lights) 1 Westinghouse automatic	Direct. 390 Revs.	9,300	75	42	41

Lead covering is also required as a protection against mechanical injury. We are so exposed to short circuiting and corrosion from salt water that the high standard called for is most wise. All switches, junctions and safety-boxes, and in fact all parts of the circuit, should be thoroughly insulated. Difficulty has been experienced from salt water running along the wires into lamp-sockets, short-circuiting the lamps. The insulation of the whole circuit is sometimes required to be at least 1,000 ohms for each volt at the terminals of the dynamo.

In marine installations we need measuring instruments, both ammeters and volt-meters, which are independent of both gravity and magnetism. We want some kind of an instrument like a dynamometer, perhaps, which would be independent of the earth's magnetism and would not be affected by the local magnetism of the ship. Another thing which is necessary is the independence of the needle from the effect of the rolling of the ship. This has been already met by Sir William Thomson in his marine galvanometer, and, I think, in some recent instruments which I have not yet seen. The simplest way, apparently, is to suspend the magnet or needle by a suspension which passes through its center of gravity. If this is accurately done, of course the force of gravity has no moment to act upon, and the rolling of the ship does not affect the needle at all.

The Brennan Torpedo.

(From the English *Nautical Magazine.*)

THE recent experiments at Portsmouth on the old iron-clad *Resistance*, and the results of the trials of torpedo-boats in a Channel cruise, have had the effect of considerably discrediting the torpedo as a weapon in naval warfare.

It therefore comes upon us almost as a surprise, that the Government has bought the right to make a new torpedo from its inventor for so large a sum as £110,000. There is at least some satisfaction in knowing, when Imperial and colonial matters are so much in the foreground, that this very fortunate, or extremely deserving inventor is an Australian. Mr. Brennan's torpedo first came under the notice of the Admiral in command of the Australian squadron more than five years ago, and the inventor was induced to come with it to England.

A long series of experiments was instituted, most of them being carried out at Garrison Point Fort, Sheerness, a place which recommends itself as having a large extent of water, and of sands at a distance out which dry at low water; also as being a very retired spot, where secrets would be tolerably safe from the prying eyes of the correspondents of the daily press. Mr. Brennan was at once awarded £5,000 for his invention and a salary of £1,000 a year while necessary to complete and perfect it; and now he has received a further sum of £100,000.

The submarine mine is a well-known method of coast defense, but requires the protection of forts, and must be fired from a shore station, possessing the further disadvantage that it cannot be readily moved. The engineers in charge of it have to wait till the prey comes to them. The ordinary fish-torpedo, on the other hand, not only travels to meet the enemy, but the base of operations is also mobile. It may be started from a ship, from a small boat, or from a station on shore. The means of locomotion are contained in the torpedo itself; all that is necessary is to drop it into the water, and set it going in the direction of the enemy. There is a third class of torpedo, to which this new one belongs; movable, but requiring a fixed basis of operations, because the locomotive power is not contained in the torpedo itself, but is communicated to it from the shore. Some torpedos of this class are moved and steered by electricity, but the one which has now been purchased by the Government is worked by mechanical power communicated by a wire. The system of propulsion is the chief feature in which it differs from all other inventions of its class; but it will, perhaps, be more convenient to refer to this part of our subject last.

The present Brennan torpedo is 25 ft. long, 3 ft. beam and 2 ft. 6 in. depth; its weight fully equipped is 25 cwt., its speed 20 miles per hour, and range from 1½ to 2 miles.

It will run either on the surface or at any desired depth, and the depth is maintained by two horizontal rudders placed at the bow, which, by an automatic arrangement, depending upon the water pressure at any given depth, are turned up or down or kept level, as may be necessary to keep the torpedo at the required depth. This is a similar arrangement to that made use of in the Whitehead and other torpedoes. The ordinary charge is 200 lbs. of gun cotton.

One important feature is the means adopted to indicate the course to those who are steering the torpedo from the shore. At first a flag was carried along by it, but this was found to detract materially from the speed, and the method now used is to have a chamber filled with a similar composition to that used in the well-known Holmes' lights. When the torpedo is launched, water enters the chamber, and then, throughout the run, flames and smoke issuing from the composition indicate the course.

The Brennan torpedo is steered and propelled from the shore, and the real merit of the invention consists in the way in which this is done. There are two propellers, one moved by a solid shaft, and one by a hollow shaft, which encloses and runs round the solid shaft. Each shaft is connected with a large drum, the drums being in the midship compartment of the torpedo, and having, when it starts, a large quantity of wire tightly wound round each of them. The ends of the two wires pass out at the top of the torpedo, and overguides placed at its after end and running ashore are attached to a winding machine, whose rapid revolutions pull in the wires and turn the drums in the torpedo, thus turning the propellers, by means of which the vessel is driven at such a speed as to overcome the tension of the wire itself, and, further, to travel through the water at a rate of 20 miles per hour. The drums turn always in one direction, but one of the shafts has gear attached to it, which causes the propeller belonging to it to revolve always in the contrary direction. One propeller always turns from right to left, the other always from left to right. This arrangement tends to keep the torpedo in a straight course. It can, however, be steered, and this is done by means of two rudders—one on each side. By an exceedingly ingenious arrangement, which we are not able to describe in the space at our disposal, it is provided that when both propellers are turning at the same rate, both rudders are inoperative. If, however, one of the propellers is slacked, the starboard rudder comes into play, and similarly with the other. It is thus in the power of the party on shore, in charge of the winding machine, to steer the Brennan torpedo, but it can only be steered from its first course 30 to 40 degrees either to port or starboard, and it cannot be turned round. We cannot but consider the latter a most serious drawback in a torpedo actuated from a fixed base. The Brennan torpedo is driven by a pair of engines on shore, running at great speed and capable of working up to 100 H. P. The great speed of the torpedo is partly owing to its form, which is that of least resistance for submarine propulsion.

It is claimed for it that it will be less expensive than the Whitehead torpedo, as the machinery is on shore, and, consequently, the fish-torpedo itself, which is necessarily lost when used, is comparatively inexpensive. Against these advantages, however, must be put the great drawback that it can only be used from a base ashore in a fort, and by means of a heavy, fixed engine. It is certainly most difficult to understand the lavish generosity of the War Office in paying £100,000 to its fortunate inventor.

Triple-Expansion Engines.

(From the *Nautical Magazine.*)

THIRTEEN years have elapsed since a triple-expansion engine was fitted on board the steamer *Propontis*, and although it is true that, during the seven years following that event, no other cargo steamer was similarly fitted, still there has been sufficient experience to enable those immediately conversant with the working and building of this new type of engines to come to a decision as to

the practical value of this recent departure in marine engineering.

The latest contribution to technical literature on the question of triple-expansion engines is a paper read before the Northeast Coast Institution of Engineers & Shipbuilders, by Mr. J. P. Hall, Manager of the engineering department of Palmer's Shipbuilding & Iron Co., Limited, Jarrow-on-Tyne, and it is well worthy of consideration.

In the outset, Mr. Hall presents five queries:

First: Can triple-compound engines, with three cranks, be made to indicate the same power as the ordinary double compound, and only to occupy the same space in the ship? The figures adduced by Mr. Hall showed that, in many cases, a greater indicated horse-power has been obtained with triple-expansion engines, without increasing the length of the machinery space. Sometimes an engine-room is made larger than absolutely necessary, in order to obtain the advantage of the 32 per cent. deduction for propelling power from the gross tonnage; but, in all cases, if it be required, the engines can be so designed as to have three cranks, and to attain the same power as in a steamer of the same size having compound engines.

Second: Can the same indicated horse-power be obtained without increasing the total weight of machinery?

Elaborate tables have been prepared by Mr. Hall, bearing on this and other questions, and from them it appeared that from 450 to 460 lbs. per indicated horse-power was the weight of triple-expansion engines and boilers, as against 480 lbs. per indicated horse-power for compound engines. This reduced weight was attributed to the smaller boilers, condensers, pumps, valves, etc., which the higher pressure of steam permitted to be used; and, although, in the after-discussion, there was not unanimity as to the possibility of effecting a considerable saving of weight—in triple-expansion engines, constructed under ordinary commercial circumstances, Mr. Hall's figures were not materially affected.

Third: What about the wear and tear of machinery; will it be excessive as compared with the ordinary compound engine? It is satisfactory to learn that the past experience of a large number of shipowning firms confirms the opinion held by the writer of the paper, that instead of there being excessive wear and tear with triple-expansion engines, with well balanced cranks, there should be less. Messrs. Thos. Wilson, Sons & Co., of Hull, who were one of the first firms to have their steamers fitted with triple-expansion engines and have had three constantly at work since 1882, state that out of their fleet of 65 steamers, the least costly engines to maintain is a set of triple-expansions.

The adoption of metallic packing for piston-rods and feed-pumps, usual with many engineering firms, and which shipowners should insist on, tends to reduce the labor, cost and detention consequent on the use of the commoner kinds of packing, which, although found generally efficient for the lower pressure of steam employed in compound engines, are not good enough with the increased pressures of steam now in vogue.

Fourth: Will the life of the boiler be as long as that of those loaded to 80 or 90 lbs. pressure?

The answer to this question has, to many minds, been highly problematical, but, in boilers carefully looked after, it appears there is every reason to expect that the boilers used with triple-expansion engines will last longer than those of a lower pressure. This is due to various causes, amongst which figure the adoption of steel and the improved boiler-making plant and mechanical appliances now used by all first-class firms. The increased supervision of the manufacture of boilers by the Surveyors of Lloyd's Register and other interested parties has also not been without its favorable influence on the quality of workmanship and material. Mr. Hall's views on this question were amply corroborated by gentlemen who have frequently to examine steel boilers.

Fifth: Is any more skill required in looking after the machinery and boilers at sea?

As regards the engines, the answer to this question was in the negative; but, as regards the boilers, it was stated the feedwater supply should be sharply looked after. Many failures, by the collapsing of furnaces, are largely due to deposits from salt water causing the plates to become excessively hot, so that, whenever possible, fresh water should be obtained. The waste of water in boilers of high pressure should be reduced to a minimum, and scumming and blowing down should be avoided. Mr. Hall advocated the use of zinc plates and a daily supply of common soda, which gives a slight scale, in most cases, and protects the surface of the steel from pitting. The application of some easy and simple method of making on the voyage the required amount of fresh water to meet the demands of waste, etc., and thereby reduce the deposit to a minimum was also favorably noticed.

As regards coal economy in respect of vessels fitted with triple-expansion engines, the average results of vessels built by six firms of shipbuilders and manufacturers of engines showed a saving of 25 per cent., although, in comparing two steamers, practically identical in other respects, the reduced consumption of coal in the vessel with triple-expansion was 22 per cent. as compared with the ordinary compound engine.

There is a difficulty in assigning the exact amount of saving effected by the triple-expansion engine, as this advance in marine engineering has usually been accompanied by the adoption of mild steel in the hull of the vessels in place of iron. Steel vessels of 2,000 to 4,000 tons dead weight are better carriers by 7½ per cent., due to the lighter scantlings; but, allowing for this, it appears that there is a saving of 20 per cent. in the weight of coal consumed by the adoption of the triple-expansion engine and higher pressure of steam. Doubtless, this saving is further increased by the saving of port dues and other expenses, and detention incurred by more frequent re-coaling on long voyages.

Taking typical cases of steamers of 3,000 tons dead weight, steaming 250 days per annum, in the case of compound engines, 16¼ tons per diem being consumed as against 12½ tons with triple-expansion engines, at 20s. per ton, Mr. Hall stated the saving would represent nearly £1,000 per annum, which, on a value of £23,000 for the steamer complete, represented 4.34 per cent., without taking into consideration any other advantages the new type of engines may possess. Actual tabulated results were also given in confirmation.

The question of renewing engines and boilers in vessels fitted with compound engines was also dealt with. In the event of finances allowing it, Mr. Hall thought the better course was to take out the old engines and boilers and replace them with new ones, using the old shafting; and, where this was not advisable, he advocated the addition of a cylinder, etc., forward of the present ones; as, in placing one cylinder on top of another, the advantage of a well-balanced engine was not obtained.

It will be satisfactory for those shipowners who have steamers fitted with triple-expansion engines to learn that that type of engine will hold its own for some time to come. It is granted that quadruple-expansion engines can be worked economically at 150 to 180 lbs. pressure, but Mr. Hall considered the triple-compound—three-crank—engine will be as effective as the four cylinders arranged tandem fashion on two cranks: in the latter case, the work of the sea-going engineer being increased and rendered less accessible.

In dealing with the question of improving the efficiency of existing vessels with engines of the now nearly antiquated ordinary compound kind, it is to be regretted that prominence was not given to the advantages, from a shipowner's point of view, derivable from the adoption of forced draught which, properly considered, is germane to this aspect of the question.

The alteration of compound into triple-expansion engines has been widely advocated by engineers; but may not the increasing of work in the engineering establishments have to do with this advocacy? As regards new steamers there does not appear to be room for two opinions, but in the case of existing steamers the question assumes another aspect. There are new boilers and alterations to the engines to pay for; and, if a steamer's boilers are not worn out, it would appear to be the wiser course to adopt an approved system of forced draught,

as it has been found possible, certainly when using inferior fuel, to effect a far greater saving than by the adoption of the higher pressure steam, leaving out of consideration the far greater outlay of capital required in the latter case. If forced draught were being generally applied to boilers of 150 lbs. pressure, with a further increase in economy, possibly our views would admit of modification; but, up to the present moment, we have not learned of even isolated instances of this character.

A Method of Telephonic Communication between Ships at Sea.

[Paper read before the American Association for the Advancement of Science, at the New York meeting, by Professor Lucien J. Blake.]

In February, 1883, while investigating at Berlin the experiments of Colladon and Sturm as to the velocity of sound through the waters of Lake Geneva, the thought occurred: Why not make a practical use of water as a means of communicating between vessels at sea? Several methods were immediately devised, with the valuable suggestions of Dr. Koenig, Assistant in the Physical Laboratory of the Royal University, but actual experiment had to be deferred until a return to the United States in June of that year. At that time apparatus was prepared, and a course of experimentation has since been carried on to the present time, with more or less interruptions and more or less success. It may possibly prove interesting to learn of the methods employed and of the progress made. Further, perhaps, in the experiments, something suggestive may be found which will enable inventors to follow out in detail the system proposed. As far as the writer knows, the thought, the experiments and the whole scheme antedates all methods which have been proposed for fog signaling by telephone at sea.

Briefly, the plan was as follows: A sound-producing apparatus was to be attached to each vessel and to be worked under the surface of the water. In times of fog or night, a code of signals would be produced by it which would be transmitted in all directions through the water, with a velocity four or five times that in the air. Each vessel, in addition to the sound-producing apparatus, would be provided with a sound-receiving apparatus, which would take up out of the water the signals arriving from neighboring vessels. All of us remember when, as boys in swimming, how distinctly the sound of the striking of stones together under water was heard. Just so distinctly it is possible to send musical tones from one ship to another.

For steamships, the sound-producing apparatus was designed to be a steam fog-horn or whistle, specially constructed to sound under water, and to be heard at least from six to eight miles. From the nature of its tone it would be easily distinguishable from other sounds always more or less present under water, such as from breakers, waves, etc. With such whistles a Morse alphabet of long and short blasts and pauses was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell buoys were to have a second bell added under water, while lightships, light-houses and any headlands might also be provided with submerged bells which could be rung from the shore, if necessary. Sailing craft, both large and small, would have bells, and since an ordinary locomotive bell can be heard, according to my experiments, at least two miles under water, such simple means would seem to afford sufficient limits for protection for such vessels.

As to the receiving apparatus, with which each vessel was to be provided, the original plan of 1883, and which has not been changed, was to employ some form of telephone acting as a transmitter under water and connected with a receiver within the vessel. The surface of the transmitter exposed to the water, and which must receive the sound waves, must be protected against ice, barnacles, heavy waves, etc. One design was that one or more vertical pipes in different parts of a ship were to extend from the vessel's interior through the hull, near the keel, and be open to the free admission of water at their lower ends; their upper ends were to extend within the vessel a little way above the keel, and were to be plugged, so that the water could not overflow into the vessel. These pipes would then provide columns of water always still, and would communicate directly with the water outside. Sound would then enter and pass up these pipes, and would encounter microphonic transmitters placed suitably in them. Wires from the transmitters could run to a small room, secluded wherever convenient in the ship, away from disturbing noises, and here telephone receivers would be placed and observers stationed in night or fog.

For small craft it was found by my experiments that a pipe shaped much like an old-fashioned powder horn with a thin flexible membrane stretched tightly across its broad end made a successful receiver. With the small end made to fit the ear, and the diaphragm end only a few inches below water, the sound of a hand bell has been received nearly a mile distant. Colladon and Sturm used a somewhat similar receiver and heard a heavy bell 10 miles.

Such is the outline of the plan as conceived and experimented upon in 1883. In the long-distance experiments a locomotive bell or some form of gong was used, while in the laboratory, various automatic devices for producing sound under water were employed. First, it was necessary to devise the best form of receiving apparatus. Nearly all existing forms of telephones were first tried. The Bell receiver and the Blake transmitter will not work under water. The first success was obtained by a form of transmitter resembling the Ader. A cigar-box cover, from its good resonant qualities, formed the diaphragm; to this four small carbon blocks were screwed at the four corners of the square; four cylinders 2 in. long, of electric-light carbon, formed the sides of the square and rested with their taper ends lightly on the blocks; the carbons were put in series with a battery and Bell receiver. With this transmitter, with the help of E. W. Rockwood, Assistant in chemistry at Cornell, signals were transmitted and received between boats one-half mile apart on the Taunton River in 1883. The water, however, would spoil the contacts of the transmitter after a use of about 15 minutes. To obviate this the carbons were attached to the inside of a resonance box, which was then made water-tight. This, however, failed to make the transmitter markedly better. The transmitter was weighted to float at different depths, but in all positions, as regards the approaching sound waves, it received equally well. Up to about a half-mile the signals from an ordinary dinner bell were distinctly heard. The higher overtones of the bell seemed to be quenched so that the sound come muffled. The experiments seemed to indicate that a transmitter dependent upon a variable contact might yet be made which would work with satisfaction. This line was consequently followed up for the next year or so. It might be stated that, later, with apparatus similar to that already described, signals were transmitted between boats a mile distant off Stone Bridge, near Newport, R. I., in the same summer of 1883, through a rough sea and in a dense fog. These latter attendant circumstances have nothing to do, of course, with the principles of sound transmission and reception, but gave encouragement that the method was independent of the state of the water outside.

From this time, various forms of microphonic transmitters were constructed, and experiments on Long Island Sound and on the Wabash River, at Terre Haute, Indiana, were conducted as limited opportunities of time permitted.

In September, 1886, Mr. Jesse Kester, a young practical electrician, became interested, and with his valuable aid, the experiments have been carried on with many interruptions to the present summer.

One form of transmitter which has worked fairly well consists merely of a diaphragm having within itself the elements of a microphone. It is placed in simple voltaic circuit with a Bell receiver. This diaphragm it made out of hard carbon, in granules about the size of the smallest shot. A paste is made of these with rubber cement, and this, in a mold and die under heat and pressure, becomes a

hard, thin, elastic disc. The electrical resistance is very high, and can be altered according to the per cent. of rubber cement present. This disc or diaphragm takes up the sound vibrations excellently well out of the water, the rubber giving the requisite elasticity. The diaphragm vibrations produce corresponding varying pressures at the innumerable points of contact of the carbon granules. The action is of course similar to that of a multiple contact transmitter.

One difficulty, however, was found to lie in the gradual deterioration of elasticity under the action of salt water. Further, the brittleness of this diaphragm, especially when the carbon granules were comparatively large or in large proportion to the cement, rendered it liable to rupture by a strong wave or by any foreign substance striking it under water. A paste with celluloid was much tougher and seemed a slight improvement. As a transmitter in the air, this worked very nicely, and of course without the buzzing of the Blake. But no attempt was made to develop it further for this purpose.

To avoid this brittleness, diaphragms of wood and metal were tried with one or more carbon buttons. These buttons, however, differed from the Blake or Edison in that the change of pressure which produced the undulatory currents operating the receiver did not occur at the surface where the button made contact with platinum or with other carbon pieces as in these latter, but the variations of pressure took place within the button itself. To do this, these variable-pressure buttons were made as follows: Fine granules of retort carbon were sorted to uniform size through a sieve with meshes about 900 to the square inch. These were then first plated with copper, then with silver, and thirdly with a thick coat of platinum. These different platings seemed necessary to make the platinum "stick" (adhere), so to express it. At the end of the platings there remained grains of high electrical resistance, exposing many points and irregularities for contacts. These grains, in different proportions, were mixed with rubber cement and a set of hard elastic balls, about the size of peas, and thick discs molded out. These were included in a voltaic circuit with a Bell receiver, and the diaphragm rested lightly against them. Such an arrangement proved very sensitive to vibrations of the diaphragm under water. In the laboratory experiments a watch on a floating board could be heard through the water about 3 ft. distant.

On the river, however, through a long distance, these did not seem sufficiently satisfactory. This difference in action between a long and a short distance led to the thought that, as the advancing front of the sound wave is an arc, approaching in curvature nearer and nearer the tangent to its circle, a large diaphragm would receive more sonorous energy and thus probably prove more effective. This is the point to which the experiments have now been carried, and the next trials will be with a diaphragm 18 in. square.

It is believed that sufficient has been done, however, to show that the complete solution of this interesting and valuable practical scheme will lie probably in the telephonic method just described or in some modification of it; at least, by this method, in October, 1885, signals were transmitted and received 1½ miles on the Wabash River from a locomotive bell around three or four windings of the river, so that the operators were out of each other's sight, and the sound could not be heard through the air, yet could with fair distinctness through the telephone.

It is hoped that experimenters may find in the above methods and experiments enough to encourage further investigations, and with this end in view, and from the fact that the writer is, for the present, by circumstances, turned to a different line of investigation, this article has been prepared, and the experiments thus for the first time made public.

Primary Batteries.

(From the London *Times*.)

ATTEMPTS continue to be made to introduce electric lighting in the household and in mines by means of primary batteries, and we have recently inspected two more inventions of this character. The first of these is the "Eclipse" portable electric battery, which is the invention of Mr. Harris, and is being introduced by Mr. J. J. Walsh of White-house, Telegraph-street, London. This battery consists of a series of outer cells of vulcanite, each outer cell carrying an inner cell of porous material.

The outer cell is filled with a solution of sulphuric acid, and the inner cell with a solution of nitrate of soda. A carbon rod dips into each inner cell and constitutes the negative, while a plate of zinc is held in the acid solution in each outer cell and forms the positive. A miners' safety lamp has been constructed upon this principle, and a 2½-candle power lamp, assisted by a reflector, gives a very good all-round light, which is also reflected upward to the roof. At a demonstration which recently took place at Mr. Walsh's offices a number of lamps were driven from an Eclipse battery, and gave a very effective light. Upon that occasion Professor Silvanus P. Thompson spoke strongly in favor of the system, especially as applied to miners' lamps. The Great Western Railway executive, it is stated, has tested the lamp with very satisfactory results. The first cost of the battery is said to be very small, and the cost of each charge only 2*d.*, which charge will maintain a lamp for 24 hours. The second primary battery to which we have to refer is the invention of Mr. C. M. Newton, and is being introduced by the New Electric Light Syndicate of 2a West-street, Finsbury, London. Each cell of this battery consists of an outer case of iron, which forms the negative plate of the cell. On the bottom of this the depolarizing material (oxide of lead) is spread. Above this is a diaphragm of parchment paper so disposed as to divide the cell into an inner and an outer compartment; and at the top, resting on glass insulators, the zinc positive plate is laid. The exciting fluid, a caustic alkali, is poured into both compartments, and the cell is ready for use. There are no fumes from this battery, which has been fully tested and favorably reported on by Dr. R. M. Walmsley, F.C.S., who states that a brilliant and steady light is maintained for 120 hours without attention, and that local action is practically negligible. It is intended to let these batteries to consumers at a nominal rental, the price to be charged to the public being fixed on the basis of gas at 4*s.* 6*d.* ($1.08) per 1,000 feet. The battery is to be recharged as required by the company, so that no risk will be incurred by domestics in dealing with it. At a recent demonstration, a good light was given by six 10-candle power Shippey Brothers' glow lamps, driven by seven Newton cells through seven E.P.S. accumulators. It is stated that the accumulators would not be used in practice. Including the present, we have, within the past three years, noticed no fewer than 11 primary batteries, all of which have given more or less promise during experiment. It would be interesting to know how many of these have been introduced into houses of moderate size for ordinary domestic lighting on a regular, practical and commercial paying scale to the supersession of gas

Electric Power Service.

[T. C. Martin, in the *Electrical World*.]

THE rapid introduction of electrical apparatus as soon as its efficiency has been demonstrated is being seen once more in the remarkable growth of the electric-motor industry. It was the privilege of the writer just a year ago to bring before the National Electric Light Association, in session at Detroit, a few facts and comments on the subject of the use of motors and the electrical transmission of power as it then presented itself. An enumeration was made of the various places at which motors had been introduced, and a few figures were quoted as to results obtained. But the material then offering itself, though striking, was notably scarce as compared with that forthcoming to-day; and to those who are in any way familiar with the development going on it is evident that the new work already in hand will, within the next year, dwarf into utter insignificance all that has hitherto been accomplished. Thus it may be mentioned, for instance, that

one well-known company shows a total output of over 2,000 small motors; that another concern manufacturing small motors up to about 1 H. P. has built 2,500 since last November; that another company within about the same time—nine months—has sold 1,000 H. P. of motors; that a fourth has, since going into operation, sold about 2,500 H. P., and is now building some 4,000 H. P., and that large factories have been put up for the special manufacture of motors, employing hundreds of men. The importance of this new condition of affairs is hardly yet recognized, but it cannot be denied. It means for one thing that even to-day the electric-light station is becoming the great public reservoir of power, and that from its circuits all engaged in manufacture, and thousands who need power for various minor services and functions, can draw supplies at will. In a very short time the consumption of current for electric power will equal, if not excel, the consumption for light, and it is to this new idea that electric-light men and the general public are adjusting their methods. There is not an electric-light station building to-day in which provision is not being made, in engines and dynamos, for electric-power supply; nor is there a manufacturing industry, within city limits anywhere, in which the use of electric motors is not to be tried or has not already begun.

It is, of course, well-known that several hundred small motors are in use at the present time, deriving current from primary batteries. It is also well-known that a large number of motors, averaging about 15 H. P. each, have been applied to street-railroad work; but it is through the medium of electric-lighting circuits that the greatest demand for motors has come and is to be met. In order to ascertain what is being done in this field, the *Electrical World* addressed inquiries recently on the subject to about 500 of the largest local lighting companies. It has been fortunate enough to secure replies from between 200 and 300 of these, and the replies constitute a very interesting presentation of the work done in all sections of the country. A large part of the information furnished has already been published but it may be well to bring out one or two points that are suggested by the replies as a whole.

It appears that not far short of a hundred local companies are now operating motors, generally, but not always, on their day circuits. A noticeable feature of the replies from companies not doing any motor business is that they "do not run day circuits." This may often be a sufficient reason, but the inquiry is admissible whether sufficient current could not be stored up from the average nightly run of a station with a spare or extra dynamo to feed a day circuit profitably. This is certainly worth trying in some places, and is being done at Cheyenne, where several motors are on a storage day circuit. Another point brought out is that the motors are largely on incandescent circuits, the reason for this being obviously that day running is far more a necessity with incandescent stations than with arc stations. Where motors are running upon night circuits they are chiefly employed on newspaper presses.

A question among electric-light men has been whether it is best to sell the motor or to rent it out. No unanimity has yet been attained, or is likely to be reached, on that head, although in a great many cases the matter of purchase is left optional with the customer. The sale outright relieves the company of a large initial outlay, but the leasing system seems productive of a much larger income in the long run.

Another question arising is that as to the desirability of selling power at a flat rate or by meter. Many of the companies are charging meter rates, but, on the whole, the flat rate, based on the capacity of the motor, appears to have a decided preference.

It will be remembered that the National Electric Light Association has discussed the propriety of fixing motor rates for its members. Pending that action, a striking variety has manifested itself. * * * *

It is still early for the establishment of special motor circuits, but there are several now up, and more are building in the larger cities. It is to be borne in mind that in New York and Boston a distinct electric power supply (Daft) has existed since 1883, that in New York now distributing over 200 H. P. to about 60 customers, and that in Boston 90 H. P. to about 20. Similar services exist in Worcester and Providence. A special power plant is also enjoyed by San Francisco, and the steps being taken elsewhere in the same direction are too numerous to record.

It remains to be seen whether the power supply will be generally undertaken by special power stations or whether it will chiefly remain in the hands of the lighting stations. In Boston, the Edison light station is running 72 motors (Sprague) from ½ to 15 H. P., with a total call for 300 H. P. of current, and in New York the Edison wires feed 45 motors of the same make with the same range of capacity, taking in all 250 H. P. The Brush companies in New York, Rochester, Buffalo, Galveston and Philadelphia have a large number of motors of different makes in use, and the Brush Company in Baltimore has about 60 motors (Baxter) on its arc circuits. At Providence, the Narragansett Electric Light Company is putting about 30 H. P. of motors (Thomson) on independent circuit.

One interesting development in New York City deserves special note. The Excelsior Steam Power Company, established as a private concern about 30 years ago for steam power distribution, and lately delivering nearly 800 H. P. over an area of four city blocks, went into the electric-motor business not long ago, running for the Electric Power Company the Daft service above spoken of. It is now understood that the company has completed arrangements for the generation and supply of 2,000 H. P. electrically, using the same system, and is already busy preparing its plant. This service will be confined to the district on the east side of Broadway, another service being meantime planned for the west side, to go in operation by the beginning of September. The Excelsior Company has been leasing its motors, charging $4 per week for 1 H. P., $6 for 2 H. P. and $3 for every additional H. P. This includes the current, the use of the machine, supervision and any needed repairs.

Some of the comments made are very significant, and in no case does it appear that the motor is at a disadvantage as an instrument of power distribution when compared with other machines. Thus, it is remarked by the local company at Appleton, Wis., that water-power is so cheap it would not pay them to run in the day time for electric-power supply. Yet it is in Appleton that the electric motor has made a splendid showing on street-railroad work, the generator being driven by water wheel. As to the size of motors, it may be said that it was at first thought that the bulk of the business would be around 5 H. P., but the demand is as brisk for motors of 10 and 15 H. P. and larger as for those of any other smaller capacity. All told, there are probably over 10,000 electric motors in America to-day, of some 15 different makes—Brush, Thomson, C. & C., Cleveland, Baxter, Van Depoele, Daft, Edgerton, Sprague, Hawkeye, Bergmann, Griscom, etc. Of one of these motors alone, over 30 types are now being built to fill orders and carry in stock—a point of no small importance as illustrating the remarkable commercial development of this latest electrical application.

The Pyromagnetic Dynamo—The Production of Electricity Direct from Fuel.

[Paper read before the American Association for the Advancement of Science, at the New York meeting, by Thomas A. Edison.]

THE production of electricity directly from coal is a problem which has occupied the closest attention of the ablest inventors for many years. Could the enormous energy latent in coal be made to appear as electric energy, by means of a simple transforming apparatus which accomplishes its result with reasonable economy, it will be conceded, probably, that the mechanical methods of the entire world would be revolutionized thereby and that another of those grand steps of progress would be taken, of which the Nineteenth Century so justly boasts.

The simple production of a potential difference by means of heat is as old as Seebeck and Melloni. The

science of thermo-electricity thus originated has been developed by Becquerel, by Peltier, by Thomson and by Tait, and the thermo-batteries of Clamond and of Noe have found many important practical uses. The results already attained in these generators have stimulated research marvelously, and many investigators have believed that in this direction lay the philosopher's stone. Our fellow-member, Moses G. Farmer, worked long and assiduously in this field, producing, it is believed, the most satisfactory results, as regards economy, which have ever been obtained. But even these results were not very encouraging. He never succeeded in converting 1 per cent. of the energy of the coal into electric energy. Quite recently Lord Rayleigh has discussed with his well-known ability the law of efficiency of the thermo-battery from the standpoint of the second law of thermo-dynamics; and he concludes that for a copper-iron couple, working between the extreme limits of temperature possible for these metals, a conversion of not more than one three-hundredth part of the coal energy can be hoped for. While, therefore, as a heat engine the thermo-cell appears to follow precisely the law of Carnot, and hence may have a theoretical maximum efficiency equal to that of the reversible engine of this eminent philosopher, yet in practice its efficiency falls very far below this theoretical maximum.

It therefore follows that if the result hoped for is to be attained at all it must obviously be looked for in some other direction than in that of the thermo-cell. In considering the matter, another line of investigation suggested itself to me, the results of which I have the honor now to submit to my fellow-members of the Physical Section. It has long been known that the magnetism of the magnetic metals, and especially of iron, cobalt and nickel, is markedly affected by heat. According to Becquerel, nickel loses its power of being magnetized at 400°, iron at a cherry-red heat and cobalt at a white heat. Since, whenever a magnetic field varies in strength in the vicinity of a conductor, a current is generated in that conductor, it occurred to me that by placing an iron core in a magnetic circuit, and by varying the magnetizability of that core by varying its temperature, it would be possible to generate a current in a coil of wire surrounding this core. This idea constitutes the essential feature of the new generator, which therefore I have called a pyromagnetic generator of electricity.

The principle of utilizing the variation of magnetizability by heat as the basis of electric machines, though clearly applicable to generators, was first applied to the construction of a simple form of heat engine which I have called a pyromagnetic motor. A description of this motor will help us to understand the generator subsequently constructed.

Suppose a permanent magnet having a bundle of small tubes made of thin iron placed between its poles and capable of rotation about an axis perpendicular to the plane of the magnet after the fashion of an armature. Suppose further, that by suitable means, such as a blast or a draught, hot air can be made to pass through these tubes so as to raise them to redness. Suppose that by a flat screen symmetrically placed across the face of this bundle of tubes, and covering one-half of them, access of the heated air to the tubes beneath it is prevented. Then it follows that, if this screen be so adjusted that its ends are equidistant from the two legs of the magnet, the bundle of tubes will not rotate about the axis, since the cooler and magnetic portions of the tube-bundle (*i. e.*, those beneath the screen) will be equidistant from the poles and will be equally attracted on the two sides. But if the screen be turned about the axis of rotation so that one of its ends is nearer one of the poles and the other nearer the other, then rotation of the bundle will ensue, since the portion under the screen, which is cooler, and therefore magnetizable, is continually more strongly attracted than the other and heated portion. This device acts, therefore, as a pyromagnetic motor, the heat now passing through the tubes in such a way as to produce a dissymmetry in the lines of force in the iron field, the rotation being due to the effort to make these symmetrical. The guard-plate in this case has an action analogous to that of the commutator in an ordinary armature. The first experimental motor constructed on this principle was heated by means of two small Bunsen burners, arranged with an air blast, and it developed about 700 foot-pounds per minute. A second and larger motor is now about finished, which will weigh nearly 1,500 lbs., and is expected to develop about 3 H. P. In both these machines electro-magnets are used in place of permanent magnets, the current to energize them being derived from an external source. In the latter machine the air for the combustion is first forced through the tubes to aid in cooling them, and then goes in to the furnace at a high temperature.

The earliest experiments in the direction of the pyromagnetic production of electricity were made with a very simple apparatus, consisting of a charged electro-magnet having a tube of thin iron passing through its cores near their outer ends, a coil of wire being wound around this tube, and including an ordinary sounder delicately adjusted in its circuit. The tube beneath the coil was covered with asbestos paper. After heating the tube to redness by a gas blast directed into it at one end, a jet of cold air was suddenly substituted for the flame, the sounder at once closed, showing that the change in the magnetizability of the iron had varied the distribution of the lines of force within the coil, and thus had produced a current of electricity in this closed circuit.

The construction of a machine of sufficient size to demonstrate the feasibility of producing continuous currents on the large scale in this way was at once begun and has only just been completed. The new machine consists of eight distinct elements, each the equivalent of the device already mentioned, consisting of the two legs of an electro-magnet somewhat far apart (12 in. actually), having at one end the ordinary yoke, and at the other a roll of corrugated sheet-iron, .005 in. thick, called an interstitial armature; this armature having a coil of wire wound upon it and separated from direct contact by means of asbestos paper. The eight elements are arranged radially about a common center and are equidistant, the eight interstitial armatures passing in fact through the iron disks which constitute the common pole piece of all the electro-magnets. The coils wound upon the interstitial armatures are connected directly in series, the whole forming a closed circuit. Through the center of these discs a hollow vertical shaft passes, carrying at its lower end a semi-circular plate of fire-clay called a guard-plate; which, when the shaft is turned, revolves close to the lower ends of the sheet-iron armatures and screens off half of them from the access of heat from below. The shaft carries a cylinder of insulating material having metallic contact-pieces let into it on opposite sides, the line joining them being parallel to the straight edge of the guard-plate. Upon this cylinder eight springs press, each of these springs being connected to the wire of the closed circuit above mentioned midway between the coils. The length of the metallic segment is so proportioned that the following spring touches it just as the preceding one leaves it. The springs themselves are so adjusted that each of them comes into contact with its metallic segment just as the preceding coil of the pair to which it is connected is uncovered by the rotation of the guard-plate. Upon the same shaft and above the cylinder just mentioned, a pair of metallic rings are placed, insulated from the shaft, to each of which one of the metallic segments is connected. Brushes pressing upon these rings take off the current produced by the generator.

The entire machine now described is placed upon the top of any suitable furnace, fed by a blast, so that the products of combustion are forced up through those interstitial armatures which are not covered by the guard-plate, and raise them to a high temperature. The field magnets, when charged, magnetize of course only those interstitial armatures which are cold; *i. e.*, those beneath the guard-plate. On rotating this plate, the interstitial armatures are successively uncovered on the one side and covered on the other; so that continually during the motion four of the eight armatures are losing heat, and the other four are gaining heat. But those which are losing heat are gaining magnetism and *vice versa*. Hence,

while currents are generated in all the armature coils, since in all the magnetism is varying, the current in the coils beneath the guard-plate will be in one direction, while that in the coil exposed to the fire will be in the other. Moreover, whenever an armature passes out from under the guard-plate, its condition at once changes; from losing heat and gaining magnetism it begins to gain heat and lose magnetism. Hence, at this instant the current in its coil is reversed, and, consequently, the line connecting this coil with the one opposite to it constitutes the neutral line, or line of commutation, precisely as in the ordinary dynamo. Indeed, the action of the interstitial coils of the pyromagnetic dynamo resembles strongly that of the ordinary armature coils of the Gramme ring, not only in the manner of connecting them together, but also in their functions, the change of direction in the current as the magnetism of the field changes sign in the latter case, corresponding closely to the change of current in the former case, due to the direction of the temperature change. But it will be observed that while in the Gramme ring the loops between the armature coils are connected to commutator segments equal in number to that of the coils, upon which commutator two brushes press, in the pyromagnetic dynamo the loops between the armature coils are connected to an equal number of brushes (in this case eight), while the commutator segments are only two in number; so that the functions of the commutator and brushes in this generator are in a certain sense reversed as compared with the ordinary dynamo.

The potential difference developed by this dynamo will obviously depend: 1, upon the number of turns of wire on the armature coils; 2, upon the temperature difference in working; 3, upon the rate of temperature variation, and 4, upon the proximity of the maximum point if effect.

No advantage will be gained, of course, by raising the temperature of the interstitial armature above the point at which its magnetizability is practically zero; nor will it be advantageous on the other hand to cool it below the point where its magnetism is practically a maximum. The points of temperature, therefore, between which for any magnetic metal it is most desirable to work, can be easily determined by an inspection of the curve showing the relations between heat and magnetism for this particular metal. Thus the points of temperature at which the magnetizability is practically zero, as above stated, are a white heat for cobalt, a bright red for iron and 400° for nickel. On the other hand, while at ordinary temperatures iron has a maximum intensity of magnetization represented by 1,390, its intensity at 220° is 1,360; and hence no commercial advantage is gained by cooling the iron below this temperature. Nickel, however, whose maximum intensity of magnetization is at ordinary temperatures, 800, has an intensity of only 380 at 220°. Hence, while this metal requires a lower maximum temperature it also requires a lower minimum one; but it may be worked with much less heat. The rate of the temperature variation is determined by the rapidity with which the guard-plate revolves, and this, in its turn, is dependent upon the rapidity with which the interstitial armature can be cooled and heated. That it may take up and lose heat readily, the sheet iron of which it is made is very thin (only 0.005 in. thick), even when its durability is increased by enameling or nickeling; it is corrugated and rolled up so as to expose a large surface (about 60 square feet for the eight armatures), and hot and cold air are alternately forced through the armature. Experiments already made show that the guard-plate can probably be made to revolve 120 times a minute. Since the potential difference is proportional to the number of lines of force cut per second, it is evident that by doubling the speed of rotation, twice as many lines of force would flow across the generating coils per second, and the output of energy would be quadrupled. Exactly what thickness of metal is the most suitable for the purpose, what the relative volume occupied by metal and by air space in the interstitial armature should be, what is the best diameter for this armature, or even the best metal, what the best limits of temperature, and what the best speed of rotation to produce the maximum potential difference—all these are questions which must be decided by experiments made upon the generator itself.

The results thus far obtained lead to the conclusion that the economy of production of electric energy from fuel by the pyromagnetic dynamo will be at least equal to and probably greater than that of any of the methods in present use. But the actual output of the dynamo will be less than that of an ordinary dynamo of the same weight. To furnish 30 lights of 16 candle-power in a dwelling house would probably require a pyromagnetic generator weighing two or three tons. Since, however, the new dynamo will not interfere with using the excess of energy of the coal for warming the house itself, and since there is no attendance required to keep it running, there would seem to be already a large field of usefulness for it. Moreover, by using the regenerative principle in connection with it, great improvement may be made in its capacity, and its practical utility may very probably equal the interesting scientific principles which it embodies.

An English Electric Railroad.

(From the London *Electrician*.)

On Tuesday last (July 26), upon the invitation of the Electric Traction Syndicate, the representatives of the technical journals were present at "a private demonstration of electrical traction on the Shoreham & West Brighton line." This line was built by a local company several years ago, but has never paid its way, and it has been in the hands of the Syndicate for experimental purposes for about 12 months past, during which period an elaborate series of tests have been carried out. The total length of the line is about 4½ miles, and presents features which are of considerable value for the purpose in view. The gradients are numerous and in some cases exceptionally severe, rising to 1 in 20 where the road crosses a bridge at Southwick, and there are two sharp curves of about 28 yards radius, one of which is on an incline of 1 in 100. When to this it is added that the road has not been maintained in very first rate order, it will be seen that the line is particularly well adapted to test the capabilities of any system of traction. Indeed, it may be remarked that Messrs. Aveling & Porter, the engine builders, have been experimenting with a new type of steam engine upon the same line concurrently with the electric trials. The average co-efficient of traction has been found to vary between 42 and 55 lbs. per ton, according to the state of the metals; upon a well-laid London line this co-efficient does not usually exceed 30 to 35 lbs. per ton.

The engineers of the Syndicate are of opinion that while electric traction upon lines where the cars follow one another at short intervals is best applied upon the cars themselves, yet that a wide field exists for the use of electric locomotives upon suburban lines where heavier loads are carried at longer intervals, and the conditions approximate more nearly to those of a railway. The trials upon Tuesday last began, therefore, with a short run upon an electric locomotive car weighing about 12 tons, and designed to draw a bogie car, with seats for 60 persons, at a mean speed of 8 miles an hour, additional accommodation for 14 persons being provided upon the locomotive itself. The motive power is obtained from a set of 168 A-size Tatham cells, discharging at 50 to 60 ampères, with a capacity of 200 ampère hours. The motor, which is of the Immisch type, series-wound, runs at 650 revolutions. The armature is 9 in. in diameter, and is geared direct to the driving-wheels by pinions at each end of the spindle, which mesh with internal teeth upon a circular rack on the wheel. The ratio of the teeth is 10 to 67. The motor is suspended by sleeves on journals cut in the axles, which are of steel, and has a tension bar from the center of the fields to the end framing to act as a fulcrum. But although this gearing has given good results in practice, yet it has been considered desirable to seek for a less expensive form of gear of equal efficiency; this having, it is believed, been found, it is not intended, as a rule, to resort to the arrangement just described. For this reason the trip of the loco-

motive was not of great length, nor were any measurements taken.

Returning to the engine house at Southwick a self-contained car was next tried, upon which the party made the journey to Shoreham. At this place a halt was made for lunch, and afterward the car traversed the whole length of the line to West Brighton, attaining a mean speed of slightly over 11 miles an hour; the maximum speed probably approached 16 or 18 miles an hour on some of the inclines. This car is capable of seating 20 passengers, and by itself weighs one ton; the weight of motor and gearing is one ton, and the accumulators 1.75 tons; a total rolling load, when full of passengers, of about 5.25 tons. The wheel-base measures 5 ft., and the wheels are 2 ft. 6 in. in diameter. The cells, which are 84 in number, are of the Tatham type, B-size, with a normal discharging rate of 45 to 50 ampères, and a capacity of 150 ampère-hours. They are divided into two separate batteries, each battery being again divided into two halves. By means of a suitable switch, designed by Messrs. Immisch & Co., the two halves of each battery can be connected either in parallel or in series, and the two batteries can also be connected in parallel or in series with each other. Out of these four possible arrangements it will be seen that two amount to the same thing electrically, so that only three different speeds are obtainable by this means. In actual practice it has been found that these three speeds fulfill all requirements.

The motor is again of the Immisch type, series-wound, and runs at 1,000 revolutions with 160 volts and 40 ampères. The experiments carried out by the Syndicate have largely been directed to the question of heavy motors running at slow speeds, geared direct, *versus* lighter motors running at higher speeds with second-motion gear. With slow-speed motors the question of weight assumes great importance, not only because the motor itself must necessarily be comparatively heavy, but because at slow speeds the torque is so great that the gearing and all structural parts connected with this or the motor have to be additionally strengthened. These additions to the dead weight, combined with the slower speed, necessitate also a greater current in starting and upon inclines, and thus reacts injuriously upon the batteries. A speed as low as 350 revolutions has been tried, but the experience gained has led to the conclusion that a considerably higher speed is desirable, even although the gearing becomes more complex. The motor now preferred runs at 1,000 revolutions and drives by means of chain gearing.

The chains are of a type specially designed by Mr. Hans Renolds, of Manchester, and the links are exceptionally heavy. By means of an intermediate shaft the speed of the driving-wheels is reduced in the proportion of 1 to 9, and means are provided for taking up the slack of both chains by shifting the journals. The gearing runs with great smoothness and an almost entire absence of noise; in fact, the car runs without more noise than a horse car.

The motor weighs about 5½ cwts., and has an efficiency of conversion at full load of 85 per cent. Its average working efficiency probably lies between 75 and 80 per cent. By winding the armature with smaller wire this could probably have been increased without reducing the normal output; but the element of safety which exists in an armature capable of taking an excessive current would be reduced in proportion. In this case the factor of safety as regards the sectional area of the wire is so great as to admit of the car being stopped and started upon an incline of 1 in 20. It was proposed on Tuesday to repeat this experiment, but time did not permit. The current, however, probably exceeded 100 ampères under this test.

The readings of the ammeter taken during the run showed that under an electro-motive force of 80 volts the current averaged 35 ampères on the level at a speed of 8 to 10 miles an hour, rising to 45 ampères on an incline of 1 in 120. When the cells were placed in series, giving a terminal electro-motive force of 170 volts, the mean speed increased to 12 or 14 miles on the level with a current of 45 ampères. On the incline of 1 in 20, and going round the sharp curves, the current increased to 80 ampères. These figures are little more than approximate, but were taken as a rough verification of the results obtained by more careful tests made at leisure by the engineers of the Syndicate. The limits of our space do not permit us to give a specimen of these tables in our present issue, but we shall probably return to the subject at an early date.

The Electric Traction Syndicate is certainly to be commended for the careful and thorough manner in which they have proceeded to work out the numerous problems connected with the details of the subject; and especially for their determination not to come before the public until a long series of trials of a thoroughly practical character had enabled them to undertake business with perfect confidence in their ability to carry it to a successful issue.

The Electric Lighting of Passenger Trains.

[Paper read before the American Institute of Electrical Engineers at its June meeting in New York, by G. W. Blodgett, Electrician of the Boston & Albany Railroad.]

A BETTER method of lighting passenger trains is demanded by considerations of economy, comfort and safety. Economy is a question which chiefly concerns the railroad management, but comfort and safety concern all their patrons. There are two ways in which we may seek these: either by improving the present system or by substituting a better one. It is doubtful whether oil lighting can be much improved and still be reasonable in cost, and whatever danger attends its use would probably still remain. I have made careful inquiry among my railroad friends without finding any instance, within their personal knowledge, where the ruins of a railroad wreck were set on fire by the lamps in the train (indeed these are usually instantly extinguished), but such an instance was said by one of the survivors to have occurred in the late disaster at Hartford, Vt., and another was mentioned at a recent meeting of the New England Railroad Club, where the explosion of a lamp set a sleeping-car on fire, and it burned with nearly all the occupants. It is, however, certain that a pile of splinters deluged with oil will burn more fiercely and be much more difficult to extinguish, than if in their normal condition.

It is therefore desirable to get rid of oil lamps for the harm they may do in *aiding* the progress of a fire, even if they do not cause one. The discomforts of oil lighting, in point of amount, distribution, unsteadiness and color of the light, corruption of the air, and the great heat given out by a large number of lamps in a car are other reasons why a change would be welcome to both the railroad management and the public, if a reliable substitute can be found. Some of the objections enumerated above apply with equal force to lighting by gas, the others are partially, but not wholly, eliminated. *Electricity*, however, offers a means of lighting which comes nearer to meeting all the requirements of a perfect light for passenger cars than any other yet discovered.

There are several ways in which we may produce the electricity for car lighting. It is possible to light a car successfully by any one of them, but further experiment is necessary to determine which is the very best to adopt, and we have already found some much better adapted than others to our American trains. The different methods will be considered in order.

1. By primary batteries. I only know of one experiment successfully going on at present. A train has been running for nearly a year between Paris and Brussels, the cars of which are lighted by electricity from a bichromate battery. It lasts for five trips of seven hours each—that is, 35 hours of lighting—without renewal, which is said to take only five minutes. No accurate estimate of cost, or more detailed information is yet at hand. There are several other batteries in the market which appear well, and if the motion of the train does not have a deleterious effect, would seem possibly adapted to this work. My own experience is conversant with only one trial of this kind, which did not succeed. Forty cells of a battery which had worked well in several house installations were put in boxes suspended from the bottom of a car, and 16 (?) lamps of 16 C. P. each, put up in the car. The lamps

burned well for one night, but the next night there was the appearance of a sudden and enormous increase of internal resistance in the battery, and it was removed for further experiment before trying to light cars. An attempt was made two or three months ago to light a New York Central passenger car with batteries of some kind, which also failed, as I am told.

Most primary batteries furnish a continuous current for so short a time without renewal that their use is debarred on this account. Some others will not bear the shaking up produced by the motion of the train. I have myself experimented for a considerable time, but thus far without finding a battery which will run on a closed circuit longer than two or three weeks, and at the same time can be carried on a train. When such a one can be found, which at the same time gives a current strong enough to light a series of lamps, it will have a great field of usefulness.

2. By a dynamo machine. There are three ways in which this has been done. A small dynamo and engine have been mounted on the boiler or tender, and the latter run by steam from the locomotive boiler. The great objection to this method is that there is no light until the engine is attached to the train, nor if it be temporarily removed. To obviate this difficulty, a separate boiler, engine and dynamo have sometimes been carried in the baggage car or on a platform car at the head of a train. It would seem that the danger from fire in this arrangement would be quite as great as by the stoves in the cars. A method tried with some success in a few instances in England and elsewhere abroad (but only once in this country to my knowledge), is to run the dynamo from one of the axles of the train, the proper speed being obtained by suitable countershafting and belts between the axle and the pulley of the dynamo. Since there would be no light when the train is at rest or when the dynamo was running at too low a speed, a battery of accumulators is added, sufficient to keep lamps lighted for the longest time when the train is standing in the station or elsewhere. When the train stops, or is at too low a speed for the dynamo to light all the lamps, they are automatically switched to the circuit of the accumulators, where they remain till sufficient speed is again attained, when they are switched back on the dynamo circuit. During the day, when the train is running, the dynamo charges the accumulators and keeps them full. They are sufficient to light the train several hours if need be. On one train in Germany, the dynamo and 26 accumulators weighed 1,350 pounds and cost about $625, operating 12 lamps; cost about 2 cents per hour, or 0⅙ cent per lamp per hour. The London, Brighton & South Coast Railway Company fitted up four trains in this way. In one train of 11 cars there are thirty-two 16 C. P. lamps, absorbing 40 ampères of current. The accumulators are stated to hold 500 ampères (probably 500 ampère-hours is meant), and when fully charged are stated to be sufficient to maintain the lamps for eight hours. This train has been running since December 19, 1883; during the first 11 months it made 2,352 trips, and ran 27,322 miles. No failures are reported. A train on the Southeastern Railway has even run a longer distance. The dynamos on these trains have an E. M. F. of 45 volts and give 56 ampères of current. Two pairs of brushes are mounted on a rocking frame, so contrived that, when the train runs in one direction by means of a lever loosely connected with the dynamo axle and varied in position by attraction of the pole pieces of the field magnets, it tilts the frame in the direction to bring one pair of brushes in contact with the commutator. If the train runs in the opposite direction, the other pair of brushes are brought to bear on the commutator. A vessel containing mercury has revolving within it a coarse-threaded screw driven by a belt from the dynamo-axle. At each end of the vessel is a vertical tube, at the upper end of which is an adjustable contact screw. When the dynamo, and, consequently, the screw, revolves in one direction the mercury rises in one tube. If the motion be reversed, it rises in the other tube, and when it makes contact with the screw, the shunt circuit of the dynamo is joined up, the field magnets are charged, the lever is drawn up and one pair of brushes brought to bear on the commutator, which completes the circuit for charging the accumulators. When the lamps are lighted and the train is in motion the dynamo feeds them, the accumulators merely acting as a regulator. If more current is being generated than the lamps require, it goes to the accumulators. If less, the balance is given out by them. When the speed of the train slackens the fall of mercury in one of the tubes breaks contact with the adjustable screw, the field-magnet circuit is broken, and the brushes are removed from the commutator, the lamps continuing lighted by means of the current from the accumulators.

The apparatus can be used for several weeks with no attention beyond lubrication, and at the end of this period only a re-adjustment of the commutator brushes is necessary, which puts the machine in condition for a like longer period. The weight of the apparatus is about two tons.

The connections between the cars are made by coupling two cables together. A slightly different arrangement of circuits has the field magnets of the dynamo wound with two wires in opposite directions, one of which is in shunt to the armature, as if the dynamo were an ordinary shunt machine. The other is wound as if the dynamo were a compound machine, and the accumulators are in series with this wire. The lamps are also in shunt with the armature.

There is a cut-out to break the circuit of the armature when the dynamo runs below a certain speed; this prevents the cells discharging themselves through it and burning it out. If the dynamo does not furnish current enough for the lamps, the accumulators supply the balance, and, in doing so, strengthen the field magnets and cause an increase of current in the dynamos. When this reaches a greater amount than that needed by the lamps, the surplus goes to the accumulators, and at the same time decreases the magnetism in the field magnet so as to preserve the balance. At the maximum speed of the machine, the cells are receiving their maximum charge, and the current to the lamps is of normal amount. Two sets of brushes are here necessary, as in the other case. Mr. Barrett, of Springfield, Mass., has fitted a train of three cars on the Connecticut River Railroad with electric lights to be run from a dynamo in something the same way as these just described. The peculiar arrangement of the trucks under an American car renders it a matter of difficulty to obtain the proper speed of the dynamo, and I am told Mr. Barrett has had much trouble with the connections between the axle and countershaft. If these are not kept tight the cable slips. If too tight it breaks. An ingenious device like a friction clamp transmits the power from the countershaft axle to a pulley upon it. This is governed by centrifugal weights balanced by stiff springs. When the dynamo runs at its normal speed these just balance the friction of the clamp, and there is no slip. Any increase of speed then causes the friction to diminish, and the pulley slips upon the shaft, till equilibrium is restored. Twenty-four Julien accumulators are connected with the circuit as a regulator, and to keep the lamps lighted when the train stops. A centrifugal governor breaks the circuit of the accumulators when the speed slackens.

3. A third arrangement of electric car lighting is by accumulators on the train, to be charged by a dynamo at a central station or terminus of the road. In England a Pullman train has been running some years lighted by electricity, supplied by accumulators charged when the train is at rest by a dynamo driven by a gas engine. The Pennsylvania Railroad Company experimented more than two years ago with accumulators charged at one end of the line. When the train arrived at Jersey City the trays containing the cells were removed from the car to a charging room, their places being supplied by spare cells previously charged. The empty ones were charged to be replaced in the first car needing its batteries changed, and these in turn to serve other cars. The changing of the cells in a car took about ten minutes. These experiments were in the main satisfactory, but the weak point was the life of the cells, the plates of which after a time buckled and fell to pieces. These cells were furnished by the Brush Electric Company for these experiments, but they declined to send out any more to be used in the same way until the Pennsylvania Railroad experiments should be ended. The estimated cost of fitting a car with 10 lamps and batteries for 70 ampère hours was about $300 per car.

In the month of January of the present year, the Julien Electric Company placed 60 cells of their accumulators in boxes on car No. 90 of the Boston & Albany Railroad, and put in twelve 16 candle-power lights in the car. These proved to be insufficient and the number was afterwards increased to 24, of which 20 were on the car and four over the platform. This car was run some two months as an experiment, with such excellent results that in March and April the trains leaving Boston and New York at 4.30 P. M. every day were fitted up with the same system. (These trains are also heated with steam from the locomotive, and there are no fires or oil lamps in any of the cars). Each coach and parlor car is fitted with twenty-two 16 C. P. incandescent lamps, of which two are over the platforms, 16 in the body of the car and the rest in the vestibules and toilet-rooms. The lamps in the car are arranged opposite each other in two rows in the top of the car, and are on two circuits entirely independent of each other, each of which has a switch of its own by which the lamps may be turned on or off. The platforms are so arranged as to be lighted from either end of the car. They may, if desired, be lighted only just before reaching a station and extinguished just after leaving it.

Sixty cells of Julien accumulators are arranged in boxes under the car, 30 cells on each side. The weight is about one ton. The boxes are neat and ornamental in appearance, and the 30 cells on each side of the cars are entirely independent of those on the other side, and are separately wired as far as the switch-board.

The cells have a capacity of 150 ampère-hours and 60 volts an each side of the car. As 60 volt lamps are used, the accumulators on each side of the car will run all the lamps, but of course for only half the time the whole will do it. They are arranged in trays of six cells each, furnished with handles; they weigh 200 pounds and can be raised from the ground and put in the car by two men. The trays are fitted on the outside with stiff brass springs, which, when the trays are in place, bear against each other, and form the connection between each tray and the next. When the trays are in place in the boxes the connections are all made. There are, therefore, no wires to disjoin or connections to make, when it is desired to remove a tray for examination or otherwise. From the boxes on each side of the car, wires are carried underneath the car to a switch-board in one of the toilet rooms, which also receives the terminals of the lamp circuits. The switch-board is so arranged that the number of cells in use can be varied from 27 in series to 30 in series, the others being added from time to time, to keep up the candle-power of the lamps, as the E. M. F. of the cells falls. Experiments are now being made to do away with the necessity for this, and if it is found practicable, it will be discontinued.

Two terminals underneath the middle of the car on either side serve to connect by means of plugs a pair of cables connected with wires leading to a dynamo in a lighting station a little way off. These terminals are of different size, so that no mistake can be made in the connections. When the accumulators are charged the whole 60 cells are placed in series; when they are connected to the lamps there are 30 cells in two series coupled together, In order that there should be no confusion or errors in doing this, I designed a switch which should, by a single movement in one direction, of four levers coupled together, throw all the cells in series and connect them to the dynamo circuit. In this position they are entirely detached from the lamp circuits and no current can pass to the lamps. When this switch is thrown in the opposite direction, the cells are cut off from the dynamo, coupled in two series of 30 cells each, and connected to the lamp circuits, which, however, do not light until turned on by the special switches for that purpose.

It is quite unlikely that an accident to either of the lamp circuits or the batteries on one side of the car would disable the other. By turning out the lamps on one circuit, therefore, the others may usually be kept burning till the train arrives at its destination. In two instances this arrangement of circuits has proved very valuable.

All the cars, except one, are fitted with Weston incandescent lamps, said to take 1.1 ampères. The remaining car has Edison lamps, which are proving so satisfactory that it is quite probable all new work will be equipped with the Edison apparatus.

When the train arrives at Boston it is put on a side track near which a line of poles has been set and the dynamo wires strung upon them. Opposite each car a pair of terminals serve to make connection with the car and the charging begins. A current of 18 ampères is run in for several hours, dropping to 12 and sometimes 10 ampères toward the end of the charge, which is now 180 ampère-hours to the 60 cells in series. If there were no loss we could draw out 360 ampère-hours in the lamps. Assuming that the lamps use 1.1 ampères each, we actually use about 22 × 1.1 ampère × 9 hours = about 216 ampère-hours, or 60 per cent. of what is put in. If the lamps are required an extra hour or two there is plenty of reserve for them. The attempt was made to reduce the charge to 140 or 130 ampère-hours, but as some of the batteries were not in first-class condition the results were not so good.

Mr. A. Reckenzaun, in a recent article on storage batteries, gives the average efficiency as not less then 70 per cent. The Julien Company claims, I understand, 80 to 85 per cent. for its batteries. Doubtless this can be realized under special condition, but my own experience would not warrant me in assuming so much in car lighting—at least until the most favorable conditions of use are better understood.

The intention is to always have a surplus of current in the battery. For the present, the trains run a round trip to New York and return with once charging, but it is not yet quite certain that it can be done in the long nights of winter.

The cost of fitting these cars with accumulators and lamps was, when complete, about $900 per car. Others fitted in the same way would cost less, as on this work the men were all inexperienced and there were no plans or precedents. The cost of operating the lights is not far from $2 per car per day, or about one cent per hour per lamp. When the lights are needed a longer time, as in the dark days of winter, the cost per lamp per hour would diminish. This is about ten times that of oil, and very nearly the same as for gas, but taking into consideration the amount of light obtained, electricity is the cheapest of the three, and immeasurably the most convenient. The light is very brilliant, well diffused, steady, and satisfactory beyond all expectations. A very noticeable feature of these cars is the great absence of heat, and the purity of the air, which is as fresh and sweet in the car at the end of its trip as before it leaves the first station; this, together with the absence of danger from fire, especially commends it for sleeping-cars. Several trains are now also being lighted with accumulators by the Electrical Accumulator Company with satisfactory results.

The electric light has come to stay. It is the only one which anywhere near fills the conditions of a satisfactory light for railway trains. It can be readily adapted to almost any conditions to be met with in practice.

Oil lamps and stoves in cars, must follow where the old couplers and hand-brakes for passenger trains have gone in this country, until electricity and steam heat have made the roasting alive of scores of people penned fast in a railroad wreck as impossible as the air-brake and the Miller platform have made the telescoping of a train into a shapeless mass of ruins, as was formerly the case. Not many years hence, we may well hope, one will be as uncommon as the other.

The Electric Lighthouse on the Isle of May.

[Paper read before the English Institution of Mechanical Engineers by David A. Stevenson, F. R. S. E.]

THE lighthouse situated on the Isle of May, at the mouth of the Firth of Forth, has recently been lighted with electricity; and as this light, besides being, the author believes, the most powerful in the world, possesses several novel features, he has the pleasure of offering the follow-

ing notes regarding it, trusting that they will prove of interest in connection with the visit to be made to the lighthouse on the occasion of the present meeting.

The Isle of May was originally lighted in 1636 with an open coal fire. In 1816, the Commissioners of Northern Lighthouses, having previously purchased the island with the right to levy tolls for the lighthouse, altered the light to argand lamps with silvered parabolic reflectors. In 1836, it was converted to the dioptric system, with a first order fixed light apparatus and a four-wick burner; and on December 1, 1886, the electric light was substituted and shown in connection with a dioptric condensing apparatus. For the last 15 years the Commissioners of Northern Lighthouses, acting under the advice of their engineers, Messrs. Stevenson, had been anxious to establish an electric light on the Scottish coast; but it was not till 1883 that the Board of Trade were able to sanction the expenditure, and suggested its introduction at the Isle of May on the ground that "there was no more important station on the Scottish shores, whether considered as a landfall, as a light for the guidance of the extensive or important trade of the neighboring coast, or as a light to lead into the refuge harbor of the Forth."

Notwithstanding the difficult access and isolated position of the Isle of May, distant 5 miles from the Fife shore, which is the nearest land, it was resolved to accept the view of the Board of Trade, and to introduce the electric light there. The necessary plans and specifications were accordingly prepared by Messrs. Stevenson; and the works begun in June, 1885, were completed, and the new light installed by December, 1886.

It was originally intended by Messrs. Stevenson to use the Brush compound-wound Victoria dynamo, giving a continuous current, and supplying a single automatically-fed arc lamp with the positive carbon *below*. This system was selected as being at once cheaper, and as giving a stronger light-power for the engine-power applied than the magneto-electric machines, which had hitherto, with success at least, been exclusively used in lighthouses. The placing of the positive carbon below was adopted in order that the strongest light might be thrown upward, so as to be dealt with by the upper part of the dioptric apparatus, and thus be more effectively utilized. The Brush Company at once set to work to produce a lamp of the above description, giving, with a current of 100 ampères and 70 volts, a light of 30,000 candle-power in the horizontal line, steady and suitable for burning in a lighthouse. This, unfortunately, they were unable to accomplish, even after numerous trials; and at last, as the buildings on the island were nearly completed and it became necessary at once to procure reliable apparatus, recourse was had to the more expensive alternate-current machines of De Meritens, which, though not so powerful, are admirably steady in working, and had given excellent results in several lighthouses and also at the South Foreland experiments.

The generators at the Isle of May are two of De Meritens's alternate-current magneto electric machines of the L type, and are of the largest size hitherto constructed, weighing about 4½ tons each. The induction arrangement of each machine consists of 5 sets of 12 permanent magnets, 60 in all; and each magnet is made up of 8 steel plates. The armature, 2 ft. 6 in. diameter, is composed of 5 rings, with 24 bobbins on each, arranged in groups of 4 in tension and 6 in quanity; it makes 600 revolutions per minute.

With the circuit open each machine develops an electromotive force of 80 volts measured at the distributor, and with the circuit closed through an arc, 40 volts. An average current of 220 ampères is developed, thus yielding an electrical energy of 8,800 watts, or 11.7 H. P. in the external circuit. The five rings are so arranged that one-fifth, two-fifths, three-fifths, four-fifths, or the whole of the current of a machine can at pleasure be sent to the distributor for transmission to the lantern; and, further, the two machines can be coupled, and the full current from both be employed. The machines are placed in the engine-room, bolted down to concrete foundations and driven from a counter shaft.

The engines are a pair of horizontal, surface-condensing steam engines, each with two cylinders of 9 in. diameter and 18 in. stroke, making 140 revolutions per minute, and each indicating 17.7 H. P. with 40 lbs. steam pressure above atmosphere and 11 lbs. vacuum. To provide against accident or failure of water supply, they have been arranged so as to be capable of being worked either condensing or non-condensing. Either of them is sufficient to drive one machine, the other engine being idle; or the two can be used together for driving both machines in thick weather. The steam to both cylinders is regulated by an equilibrium throttle-valve, which is controlled by a high-speed governor, adjusted for the engine to run at the normal speed of 140 revolutions per minute. Single, in place of compound, engines were adopted, because they are less complicated and better suited for the less skilled attendance of ordinary lightkeepers. Probably also, greater regularity in driving has thus been secured, which is, of course, a matter of the greatest importance in electric lighting, especially where, as is the case, there is only a single arc-lamp in the circuit forming the resistance. The result has been eminently satisfactory; and the engines, which were built by Messrs. Umpherston of Leith, are a most excellent piece of work.

There are two steam boilers, of which only one is in use at a time, the other being spare. Each is 20 ft. long, and 5 ft. 6 in. diameter, with one furnace flue 3 ft. diameter and 8 ft. long, having six cross Galloway water tubes. The shells are of best ⅜-in. steel plates, with the longitudinal joints double riveted; and they were tested up to 110 lbs. per square inch, the working pressure being 40 lbs. The feed is principally rain water collected from the roofs and the pavement of the court; but water can, if required, be taken from the small loch, which is also used for condensing purposes. The coal consumption is 1 cwt. per hour of lighting, which includes banking the fires during the day.

The current generated in the engine-room is conveyed to the lantern by leads, which consist of copper rods of 25 millimeters or 1 in. diameter, covered with a double waterproof wrapper. This is the first time that copper rods have been used for conducting the current for lighthouse illumination. They are constructed in 14 ft. lengths, the joints being formed with a zigzag scarf screwed up tightly by gun-metal coupling-boxes with four bolts in each. They are carried by timber bearers, placed in a groove made for them in the side of a concrete wall running from the engine-room to the tower. The total distance to the lantern is 880 ft. Several bends are introduced to allow for expansion and contraction due to changes of temperature. The loss in the leads was expected not to exceed one-sixth of the total energy generated; but it is considerably more than this, amounting to at least one-fifth.

The lamps, of which there are three, one in use and two spare, are of the Serrin-Berjot type, with some modifications—notably, the shunt or bye-pass, first introduced in the South Foreland experiments on the suggestion of Dr. Hopkinson, whereby a large percentage of the current goes direct to the lower carbon, and only an amount sufficient to regulate the carbons is passed through the lamp. This is a great improvement and prevents injury to the lamp from heating. The weak point about it, in the lamps sent to the Isle of May, was that the contact between the lower carbon-holder and the bye-pass, being necessarily a sliding contact, was effected by copper wire brushes; and these were found to wear out rapidly. On the suggestion of Mr. Munro, the engineer in charge of the station, a simple form of mercury contact has been substituted, and works quite satisfactorily.

The carbons in use are 40 millimeters or 1.6 in. diameter; but if desired 50 mm. or 2-in. carbons can be used when both machines are running. They are Siemen's make and have a soft central core of pure graphite, which has the effect of causing them to burn with greater regularity and steadiness than they otherwise would, and prevents a crater from forming and remaining at one side. The rate of consumption of the 40 mm. carbons is 1¼ in. per hour, or 2 in. including waste. The power of the arc is estimated at 12,000 to 16,000 candles when one machine only is running.

The dioptric apparatus, which was manufactured from

Messrs. Stevenson's designs by Messrs. Chance, of Birmingham, is of a novel description, the condensing principle being carried further than in any apparatus previously constructed. This principle consists in darkening certain sectors by diverting the light from them, and throwing it into the adjoining sectors so as to reinforce their light. Thus, the power of the light is increased in proportion as the dark arc is increased. Although interesting we must pass rapidly over this portion of the paper, just mentioning that an arrangement is made for dipping the light during fog which has not yet been used; but as soon as the lightkeepers, who, with the exception of the engineer, were the ordinary keepers in the service and knew nothing of electric lighting, have become thoroughly familiar with their duties, it is intended to introduce it, and probably in the same way employ a less powerful current, and say 25 mm. or 1-in. carbons in very clear weather; while both machines with 50 mm. or 2-in. carbons will be used in very thick weather. The lamps can, by a carefully designed arrangement, be changed in eight seconds.

The resulting beam of light from this apparatus is about three million candles when one machine is in use, and with both machines six millions; that is, about 300 and 600 times more powerful than the old fixed oil light. When the three-wick oil lamp is put in the focus of this apparatus the emergent beam is more powerful than the old fixed oil light with a four-wick lamp, which was 9,446 candles. The light has been picked up and recognized by sailors at 40 and 50 miles off by the flashes illuminating the clouds overhead, although the geographical range of the light is only 22 miles.

The engine-room is connected by telephone with the light-room, and the houses of the keepers are connected by air whistles or electric bells with either the light-room or the engine-room.

The new buildings, engines, electric machines, lamps, etc., have cost £15,835; and the buildings, lantern, etc., previously on the island, which have been utilized, may be valued at £6,600. Thus, the total cost of the installation may be taken at £22,435; and the cost of maintenance will not exceed £1,050 per annum. These figures are very moderate, considering the great power of the light and the isolated position of the lighthouse. To compare the cost of this installation with what it would have been if oil were the illuminant, there must be added to the above £6,600 for buildings, a sum of £2,925 for the cost of the apparatus and machine, etc., making a total of £9,525, while the cost of maintenance would have been £330 per annum. Taking these figures, and adding to the maintenance 3½ per cent. on the original outlay, it is found that while the oil light would cost 3.49 shillings per hour and 0.00017 penny per candle-power per hour, the electric light costs 9.66 shillings per hour, 2¾ times more, and 0.000038 penny per candle-power, or less than one-quarter of what the oil light would cost per candle-power. This is taking the electric-light power of one machine.

Surprise has frequently been expressed by masters of vessels, and by residents on the neighboring shores who live in view of the Isle of May light, that this light, which is so extremely brilliant in clear weather as to cast shadows at a distance of 10 and 15 miles, is so cut down by fog that some even go the length of believing the old oil light was better in fog. All who have experience of the electric light are quite prepared for the first part of this statement; while the last, it need hardly be said, is a mistake, inasmuch as the electric arc has been proved both by experiment in natural and artificial fog, and also by observations on existing lighthouses lighted by electricity, to be in all circumstances of weather the most penetrating. Every night at 12 o'clock the lightkeepers at St. Abbs Head, 22 miles distant, where there is a first-order flashing light and one of the most powerful oil lights in the service, observe the Isle of May light, while the keepers there also observe the St. Abbs Head light. The result of the last five months' observations is that the Isle of May light is seen one-third oftener from St. Abbs Head than the St. Abbs Head light is seen from the Isle of May. It is perfectly true, however, that the superiority which is so apparent in clear and rainy weather is very much reduced in hazy weather and practically disappears in very dense fog. Looking to this fact and to the large first cost and annual maintenance, the author feels that the conclusion arrived at by the Trinity House is sound, namely, that electricity should be used only for important landfall lights.

If, however, the most powerful light be desired independently of cost, then the electric arc has no rival. And if the further expense is to be incurred of introducing biform, triform, quadriform or even double quadriform lights, then the electric light is better adapted than any other illuminant, because, on account of its focal compactness and other properties, it can be so dealt with by suitably designed dioptric apparatus that the whole light evolved is effectually utilized. This is not the case with the large gas or oil flames generally used in the multiform system, in which, for this and other reasons, a considerable loss of light is incurred. Moreover, the coolness of the electric arc renders multiform lights really practicable with electricity, which can hardly be said to be the case either with gas or with oil.

The author of this paper, however, inclines to the use of hyper-radiant apparatus.

Russian Petroleum.

A REPORT made to the State Department by James C. Chambers, United States Consular Agent at Batoum, gives some interesting particulars in relation to the production of petroleum in Russia, and we present below extracts from it at considerable length:

THE PETROLEUM FIELDS.

The great petroleum producing district is about 8 miles north of Baku, and is called Balakhani, taking the name of the Tartar village near it Different parts of the district are known by other names, such as Sabunchi on the south, the Garden on the east, and Shaitan Bazar in the center; and local statisticians have again subdivided the fields into groups, of which there are 17 in the Balakhani district and 1 at Surakhani, about 5 miles southeast of the main district. At Surakhani there have been 23 wells drilled, the last one I think about the year 1879, but I find no estimate for the production of these wells, and I understand that they have produced little or no oil for several years. There is also a large refinery at Surakhani, which is supplied with crude oil by pipe-line from Balakhani.

Between 2 and 3 miles south of Baku, on the seashore, is another producing district, the area of which, as at present divided, is very small, called Bibi-Eibat. Twenty-two wells have been drilled here, and 14 of them were producing in July, 1886. In September one of those wells was drilled deeper, resulting in a large flow of oil. The production of this well, it was claimed, was from 30,000 to 40,000 barrels (42 gallons each) per day for 15 days, after which it ceased to flow entirely. This well was less than 700 ft. deep, but it was the deepest well in the Bibi-Eibat district, and had been producing from a shallower depth for two years. There is also a large and very modern refinery at this place.

DEPTH OF WELLS.

The depth of the wells varies from 175 to 1,030 ft., there being only one well of the latter depth, and I am not positive that it is producing profitably. The average depth of the wells is steadily increasing, and is now said to be 500 ft. as against 350 ft. in 1882. The average depth of new wells is, however, more than 500 ft. I think it is over 600 ft. By many it is claimed that the increasing depth of the drilling is proof positive of the exhaustion of the territory, and that the depth of the drilling increases 50 ft. for every 500,000,000 gallons of crude taken out, but I have seen no calculations as to the depth of the lower strata of oil. Others claim that both the yield and the quality of the crude improves with deeper drilling, and that the territory will continue to produce from much greater depths. From my own observation, I am inclined to believe that the quality of the crude as an illu-

minant improves as the drilling gets deeper, but as to the increase in the product I am not informed.

QUALITY OF OIL.

Even here in Russia there is a great difference of opinion as to the relative merits of Russian and American illuminating oil, and while it is not generally asserted that the Russian refined can be made as good an illuminant as the American, there is no doubt that it can be and is made to burn quite good enough for all purposes, and emits no disagreeable odor while burning.

After taking from Russian crude oil say 30 per cent. illuminating distillate, about 15 per cent. is taken from the residuum, which is called "solar oil," and which, although a nice-looking white oil, is too high fire-test to burn in ordinary lamps, and not sufficiently good for lubricating purposes. This is generally mixed with the "astatki" or crude residuum, although the last Baku congress of petroleum people "*Resolved* that its use should be made compulsory for the purpose of lighting public buildings, theaters, circuses, hotels, etc., that the use of kerosene (refined) should be prohibited in such buildings, and that the ordinary restrictions applied to mineral oils, in transportation, storage, etc., should be taken off solar oil, and it placed in the same category with vegetable oils." This is, however, only a petroleum producers' resolution, which will be understood, no doubt, in America. After the solar oil is taken, the lubricating oil distillate is taken off, and varies from 20 per cent to 25 per cent. From this distillate a very good lubricant is made, as it is affected neither by intense heat nor great cold. The lubricating oil is made in Baku, but great quantities of the distillate are also shipped to England, France, Belgium and Germany, and there purified and made into lubricating oils. After the foregoing proportions are taken from the crude, the residuum, down to about 15 per cent. of the whole, is taken off, and generally mixed with the solar oil. This is called "astatki" or crude residuum, and is the fuel of southeastern Russia. As the Caspian and Volga steamers, many of the railroads in eastern Russia, and the Transcaucasian Railroad use it for fuel, there is a great demand for it, and it sells at an average price of 0.1 cent per gallon free on board cars or steamers at Baku. The 15 per cent. left in the still is called "mazoot," and, as it will not burn, is a total waste. A few years ago it was used in limited quantities to sprinkle the streets of Baku, which was a very good idea from a sanitary point of view.

Estimated as above, the yield of Russian crude in merchantable products is about 85 per cent., as follows:

	Per cent.
Illuminating oil	30
Lubricating oil	20
Solar oil / Astatki (crude residuum)	35
Waste	15
Total	100

HANDLING THE CRUDE OIL.

Iron tanks for crude oil are but seldom used, as is also iron pipe for conducting the crude from wells to reservoirs. Instead of iron pipe, wooden box-troughs or dirt ditches are used for the latter purpose, and reservoirs are made by excavating the ground in the vicinity of the well, or by simply throwing up walls with the sand that has been thrown out of the wells. Of course there is a loss from the ground absorbing the crude, but the price is so low that this loss is insignificant. From the reservoirs the crude is pumped through pipes to the refineries, which are located on the seashore, about two miles east of Baku, at Chornai-Gorod (Black Town).

The specific gravity of Balakhani crude oil varies, but not sufficiently to make any difference in its value, so that it is all run together, forming a crude of about 0.865 specific gravity, or 32° Beaume. It contains no paraffine, and very little benzine is made from it, none of which is lighter than 0.700 specific gravity. As I have said before, I think it exceedingly probable that the crude will be of a less specific gravity as the drilling deepens, as I find the oil from Nobels' No. 32 about 0.850 specific or 34½° Beaume.

The distance from the wells to refineries is about 8 miles, and as the average elevation of the wells above the Caspian Sea is 175 ft., the piping of the crude is not at all difficult. There are now 14 pipe-lines, from 3 to 6 in. in diameter, and belonging to 13 different owners. The pumps used are either of American manufacture or made in England or Russia from American patterns, with the knowledge and consent of the American manufacturers and patentees. The latter, I am informed by men of experience with both kinds, are by no means as good as those made in America, and I have heard surprise expressed at the American manufacturers allowing their machinery to be so indifferently constructed in England and Russia.

The aggregate daily capacity of the 14 pipe-lines is about 100,000 barrels. The nominal pipeage charge is 1 kopeck per pood (about 4 cents per barrel), but the pipe-lines are generally owned in connection with both wells and refineries.

MARKETING OIL.

The great market for Russian petroleum is of course Russia itself, where it is protected from American competition by a prohibitory tariff. The Russian markets are reached principally by water transportation, *via* Caspian Sea and Volga River, to the eastern termini of the Russian railroads, and thence by railroad. Barrels were formerly used for the transportation; several barrel factories were erected at Baku and one at Tsaritzin on the Volga. The machinery in these factories is principally of German manufacture, and when made was probably as good as any in America. Now, however, it is not up to the American machinery for the same purpose. Labor was, however, cheaper than steam, and the steam barrel-works were a failure. Timber for barrels was always expensive, and the increased demand which came with the increased production made some other method of transportation absolutely necessary, and the result was the construction, for Nobel Bros., in Sweden, of a steamer to carry petroleum in bulk, which proved a great success, and completely did away with the use of barrels in the Baku trade. Nobels now have 13 of these steamers in service, carrying from 4,000 to 6,000 barrels each, all of which were constructed in Sweden and brought from the Baltic Sea *via* canal to the Volga River. The short locks in the canal necessitate the steamers being constructed so as to be taken through in two pieces and again joined together when the Volga is reached. This method of getting the steamers to the Caspian is of course very tedious and expensive, notwithstanding which there is now a large fleet of them in service.

The petroleum products are carried in these bulk steamers to a point at the mouth af the Volga River called "Davit Foot" (meaning 9 ft. of water), about 400 miles north of Baku and 90 miles from Astrakhan, where they are transferred into barges which are towed by small steam tug-boats to the various distributing points on the Volga, where tanks have been constructed for their reception and arrangements made for railroad shipments. The chief distributing point upon the Volga is Tsaritzin, about 350 miles from Astrakhan, but there is also tankage at Saratof, Kazan and Nijni Novgorod. From these points it is distributed all over Russia in tank-cars. Some is also exported to Germany *via* Riga and Libau (by sea), Eidtkunen by railroad and to Austria *via* Warsaw and Brody and Pod Volochisk. Owing to the gauge of the Russian railroad system being 5 ft., while that of the continental railroad system is the standard gauge, another transfer of the oil must be made at Eidtkunen for Germany, and at Warsaw, Brody and Pod Volochisk for Austria.

The number of tank-cars in service upon Russian railroads north of the Caucasus is 2,500, or was a few months ago, as the number is constantly being increased. The tank-car is of the same style as the modern American tanks, but of uniform size and capacity, holding, nominally, 600 poods, although usually taking 660 poods or about 3,300 gallons,

Previous to the year 1883 all petroleum products were shipped from Baku by water. In that year the completion of the Transcaucasian Railroad provided another outlet to the Black Sea. Two ports on the Black Sea, Poti

and Batoum, were available for the export trade, but Batoum was selected by this trade because of the superiority of its harbor and the advantage of its being a free port. The railroad company provided tank-cars to the number of 475 in 1883, and iron tanks were erected at Batoum. A can and case manufactory, with a capacity of about 7,000 cans and 3,500 cases per day was erected by a large refiner of and dealer in Russian oil, the machinery necessary, together with the workmen to put it in running order, coming from America. Others also started to manufacture cans and cases by hand, and the business increased so rapidly that in 1884 and 1885 the railroad company added 750 more tank-cars to its rolling stock.

The railroad from Batoum to Baku is 560 miles long, and is an exceedingly expensive road to operate, owing to the heavy grades in crossing the mountains. The highest point upon the road is the Suram Pass, about 135 miles east of Batoum, which is over 3,000 ft. above the level of the Black Sea. Upon the west side of the mountain the average grade for 3½ miles is 185 ft. to the mile, and 1½ miles of it is 238 ft. to the mile. Upon the east side of the mountain there is a grade of 253 ft. to the mile, but the greatest grade shown by the official statistics is 238 ft. to the mile for nearly 2 miles, while the average grade for 6 miles is 210 ft. to the mile. Work will soon be commenced upon a tunnel, or rather two tunnels, a long and a short one, through the mountain at Suram, which when completed will materially lessen the grade. The long tunnel will be almost 3 miles, and, as the contour of the road will have to be changed materially for 10 to 12 miles, it is estimated that the work will require about 4 years for its completion. There is some talk about the railroad capacity being temporarily increased next year by double-tracking the road over the pass, but this would also require a great deal of time and money, and I have been reliably informed that nothing of the kind is contemplated by the company. The railroad company is steadily adding new tank-cars to its rolling stock (in January 500 more tank-cars besides 350 put in service by two large refining firms). How much these additions to the tank-car service will increase the petroleum carrying capacity of the railroad I am unable to say. It requires about 1 hour and 25 minutes for a passenger-train to cross the Suram Pass, a distance of 10 miles, and for a freight-train nearly 2 hours; and with a constantly increasing general freight business it would not seem that the petroleum carrying capacity could be increased materially. The price charged by the railroad for transporting oil from Baku to Batoum is, at present rate of exchange, about 1.4 cents per gallon, and the yard charges, etc., at Batoum will increase the price to about 1½ cents per gallon.

FACILITIES FOR EXPORT.

There are now in the oil business from Batoum 10 tank-steamers, with an aggregate yearly capacity, to the ports for which they are usually chartered, of from 75,000,000 to 80,000,000 gallons; and two or three more are reported due soon, while the carrying capacity of the railroad at present is not estimated at more than 70,000,000 gallons yearly. Thus it would seem that the gratuitous (?) puffing which the Russian petroleum business has lately had in the European press, with the very plain object of sending much needed capital to its assistance, has been only doubtfully successful, inasmuch as it has resulted in sending to the assistance of the trade, not money, but ships in such numbers as to advance the price of oil their charterers are compelled to buy, in order to keep them employed, to such a figure as to make the loss from the sale of it in European markets so great as to startle even the Russian exporter, who has heretofore exhibited such a courageous disregard of financial results. The situation must undoubtedly improve; because, at present prices for Russian refined at Batoum, profitable competition with American oil at present prices at New York is impossible, even in the Levant. Some of the many steamers chartered for the trade will be compelled to remain idle at the expense of the charterer, and of course all the charterers of these vessels feel very sure that they will not suffer in this manner, but that their competitors here must, and thus allow them to continue to export at no loss, and perhaps (with an advance in prices in America) at a profit.

The lesson the Batoum trade is now learning is undoubtedly an expensive one, and may impress upon it the fact that the price of refined at Batoum, and consequently the business of exporting, are wholly dependent upon the capacity of the railroad for carrying oil from Baku to Batoum, a material increase of which seems further away than ever, since it is currently reported and believed in Tiflis that the project of tunneling the Suram Pass has been pronounced impracticable (impossible is the word used) and abandoned by the engineers who had charge of the preliminary work. Some private tank-cars will be added to the rolling stock of the railroad in the spring, but the conditions upon which these cars are accepted by the railroad company, viz., that they can only be taken over the Suram Pass after all the cars belonging to the company are out of the way, seem to indicate a doubt in the minds of the railroad officials as to their ability to handle any more cars than are now in service.

PIPE LINE.

The project of constructing a pipe line from Baku to Batoum, after having been definitely decided by a notorious English romancer, who published his specifications for the line in an English journal several months ago, was finally considered by a joint council of the ministries of Finance and State Domain, in St. Petersburg, January 12 (24 new style), and a conclusion arrived at against the construction of a line by the Government, but ostensibly favorable to the granting of a concession for the construction of a line (for crude only, and subject to strict Government control) under certain conditions, 16 in number. I have had a translation made of these conditions, and while it would no doubt prove of great interest to American readers, in showing them the remarkable ideas held by Russian pipe line experts, I do not give it because the one clause viz., "No. 10. The company must prepare all necessary pipes and reservoirs at Russian works and of Russian material," precludes any possibility of American competition for furnishing material for it, and consequently the other conditions are of no importance to Americans. I will merely say that of the 16 conditions, there are 8, any one of which would, I believe, prevent any one with even the slightest practical knowledge of the pipe-line business from accepting this concession.

Storage Batteries for Street Cars.

In a paper read before the Electrotechnischer Verein at Berlin, Herr J. L. Huber, the Engineer of the Hamburg Street Railroad, gives some very interesting details regarding the cost and operation of storage batteries on street railway lines. The system employed by Herr Huber is the Julien, in which the storage batteries are carried by the car.

In order to obtain reliable results, experiments were undertaken on a specially difficult line, both as regards curves and grades, and which, in addition, crossed much-frequented streets, so that all the difficulties met with in railroad traffic in populous cities were encountered. The road extends from the Rathhausmarkt, in Hamburg, to the Berthastrasse, Barmbeck, over the Mühlendamm, on which line very heavy grades are encountered.

The total cost given is, under these conditions, per kilometer run, for motive power, 1.5 cents; for maintenance, oil, etc., for the car motor, 0.5 cent; contingencies, 0.5 cent; renewal of plates, as above, 1 cent; a total of 3.5 cents per kilometer, or 5.6 cents per mile.

Comparing the cost of electrical power with that of horses, Herr Huber states that, to operate the usual one-horse car, which, including driver and conductor, carries 26 persons, 7 horses are required on the same line for one day of 100 kilometers run. So that, as the electric car carries 31 persons, 8.35 horses would be necessary. The cost of maintenance for horses per kilometer amounts to 4 cents (6.4 cents per car-mile). It follows, therefore, that even to-day electricity is even more economical than horseflesh, and the cost of the former can be considerably reduced by improvements.

Manufactures.

Natural Gas.

THE Louisville Gas Company, which has been boring for natural gas at a point about 25 miles below that city on the Indiana side of the Ohio River, has struck a very large flow of gas at a depth of about 400 ft. So far the flow, it is claimed, has been large enough to make the new well a very valuable one.

Aluminum and Silicon Alloys.

THE Cowles Electric Smelting & Aluminum Company, of Cleveland, O., is now manufacturing in its works at Lockport, N. Y., aluminum bronze, aluminum brass, silicon bronze and aluminum iron. The first named is an alloy of aluminum and copper; the second is made by the addition of aluminum bronze to ordinary brass. These alloys are distinguished by great strength and toughness and freedom from corrosion. Silicon bronze, an alloy of silicon and copper, has not only the qualities of strength and resistance to corrosion, but has also high electrical conductivity. Aluminum iron is a comparatively new alloy, and is used in the Mitis process for making castings of combined wrought and cast-iron.

The aluminum and silicon used in these alloys by the company is obtained by the use of Cowles's electric furnace. The company hopes to be able by this process to produce pure aluminum at a rate which will make it a commercial product in ordinary use.

Recently the oxide of chromium has been successfully reduced in the electric furnace, and an alloy containing about 12 per cent. chromium and 88 per cent. iron will be manufactured as soon as a market is assured. It is thought that this alloy will be of much service in the manufacture of chrome-steel.

Sight-Feed Lubricator Patents.

Judge Colt, of the United States Circuit Court for the District of Massachusetts, decided, on September 9, in the suit of the Seibert Cylinder Oil Cup Company against Lunkenheimer, that the Gates patent was valid.

The Gates patent is for the method of lubricating cylinders and interior working parts of steam engines showing the drops of oil passing up through water or other liquids enclosed by a transparent chamber, being that form of sight-feed lubricator known as the "upfeed."

This decision, it is claimed, covers a very large part of all sight-feed lubricators now made, and is of importance to manufacturers of those articles.

Electric Railroads.

THE electric railroad at Asbury Park, N. J., is in operation. The Daft motor is used on this line.

THE first section of the electric railroad in St. Joseph, Mo., is now in use with one car. This section is a mile long, and the overhead system is used.

THE Daft system has been adopted for the College Hill road at Easton, Pa., where a grade of 8½ per cent. has to be dealt with. The road will be about one mile long and will have three motor cars. The overhead system will be used. The cost of the road will be about $18,000 it is said.

THE electric motor of the Wharton Company, of Philadelphia, was tried recently in the presence of officers of Citizens' Passenger Railroad of Baltimore. The motor is on the storage-battery system, and the machinery and batteries weigh in all about 3,200 lbs. This motor has been tried a number of times with much success.

THE cross-town road through Fulton Street in New York City has been delayed in its construction, the conduit for the electric wires being still incomplete. It will probably be ready to work in October. The delays have been due to the electric-light junction boxes, the sewer-heads and the pipes of the water and steam-heating companies. These companies are removing their pipes at the railroad company's expense, but have been unavoidably delayed in obtaining materials. The removal of the sewer-heads has been very expensive. The engines, cars, boilers and machinery of the road are completed, and as soon as the obstructions in the streets are cleared the road will be rapidly finished.

Marine Engineering Notes.

THE Continental Iron Works in Brooklyn, N. Y., have recently taken orders for a number of their corrugated furnaces for marine boilers.

THE shipyards at Detroit, Mich., are busy, and several contracts for large vessels for next year's business on the lakes are under consideration.

THE Wheeler yard at Bay City, Mich., has just laid the keel of a wooden steamer which will be 284 ft. keel, 41 ft. beam and 23 ft. hold. She will have triple-expansion engines.

THE Milwaukee Tug Company has contracted with Reiboldt & Walters, of Sheboygan, Wis., for a 290-ft. steamer to carry 100,000 bushels of wheat. She will have triple-expansion engines and steel boilers of the Scotch pattern.

NEAFIE & LEVY, in Philadelphia, have taken a contract to build an iron steamer for the Oregon Improvement Company. The new steamer will be 240 ft. long, 35 ft. beam, 20 ft. depth of hold and will draw 12½ ft. when loaded.

THE Davidson yard at Bay City, Mich., is building two steamers for the Lake Superior trade, which are to be 235 ft. keel, 37 ft. beam and 20 ft. molded depth. The engines will be compound, with cylinders 22 in. and 46 in. diameter and 40-in. stroke.

THE new steamer *Parthian* was recently completed at the yard of the Harlan & Hollingsworth Company in Wilmington, Del. This steamer is intended for the outside line between Philadelphia and Boston, and is guaranteed to make 14 knots an hour in regular service. Her extreme length is 247 ft., beam 38 ft. and depth of hold 26 ft. The machinery consists of compound engines, with cylinders 30 and 56 in. diameter with a stroke of 54 in.

ON the night of September 7, the steamer *Pilgrim*, of the Fall River Line, broke her crosshead while off Watch Hill and was towed into New London by the steamer *Bristol*. The entire force of the *Pilgrim* at once set to work to remove the crosshead, and Mr. Pierce, Supervisor of the Old Colony Steamboat Company, immediately went to Bridgeport, Conn., and proceeded to the Bridgeport Forge Company with the broken forging. The new crosshead, weighing in all about 4 tons, was forged, fitted and ready to put on board the *Pilgrim* on the morning of September 11.

THE Detroit & Cleveland Steam Navigation Company will it is said, build a new steamer for passenger business between the two cities named. The new boat will have the same dimensions as the *City of Cleveland*, now owned by the company, as follows: Length of keel, 270 ft.; over all, 283 ft.; breadth of beam, 40 ft.; over all, 70 ft.; depth of hold, 16 ft. The hull will be of steel, and divided into water-tight compartments by steel bulkheads. She will have a low-pressure, condensing, beam engine of 2,400 H. P., with cylinders 60 in. in diameter and 12 ft. stroke and feathering paddle-wheels.

An Electric Mine Railroad.

AN electric mine railroad designed by Mr. H. M. Schlesinger is in operation in one of the Pennsylvania Railroad Company's mines, situated at Lykens Valley, in Dauphin County, Pa. The electric road proper is in drift No. 1 of the Lykens Valley collieries, and is at the present moment one mile long inside the mine and about 300 ft. outside. The drift runs into the side of the mountain.

The electric motor hauls the cars out of the end of the drift and at present brings them to daylight only, and from there they are taken by a steam locomotive to the breaker. The intention is, later on, to have the electric motor take the cars direct to the breaker. The road has an average grade of 3 in. in 100 ft., but there are two heavy grades up which the empty cars, and two heavy grades up which the loaded cars have to be hauled. The road has a large number of curves, one having a radius of 30 ft. and another a radius of 25ft. only.

The generator is placed in an engine-room outside the mouth of the drift, and from it the current is conveyed by means of a 25 lbs. rail to the motor. This rail is fastened to props at the side of the track and is from 22 in. to 5 ft. 6 in. above the track. It is put in the lower side of the gangway in such a position that the miners need not come in contact with it. Although the electro-motive force used is 350 volts, it is perfectly harmless, as has been often tested by the miners themselves. For the return current, the tie rails proper

are used, brass plates being put under the fish plates to insure a proper metallic connection between the rails. Both tie rails are joined together by a copper wire every hundred yards.

The locomotive car consists of a small wooden frame having a wheel base 49 × 40. and 30-in. wheels. On the frame between the axles the electric motor is placed, and the power is transmitted to the axles by means of chain gearing. The electric motor proper weighs 1,500 lbs. and runs at a speed of 1,100 revolutions. The locomotive is run at a speed of 6 miles an hour, and it has already attained speeds as high as 15 miles. The number of cars it can haul is 30, each weighing, fully loaded, 4 tons. The locomotive car, with ballast, weighs about 7½ tons.

The cars have been in operation ever since July 26, doing the entire work in the drift, without a single stoppage. It is placed entirely in the hands of a boy 18 years old. The round trip is made in 25 minutes, the motor doing all the necessary shifting inside the mine. It would take mules 90 minutes to accomplish the same amount of work.—*Electrical World.*

Manufacturing Notes.

THE Western Steel Works at Carondelet (South St. Louis) are putting in a set of rolls for making steel rails of light section.

THE Builders' Iron Foundry in Providence, R. I., recently cast a bed for hydraulic press in a single block weighing 55,000 lbs.

THE Bucyrus Foundry & Manufacturing Company in Bucyrus, O., has recently shipped several steam excavators to Mexico.

THE Springfield Iron Company started up its new Bessemer-steel plant at Springfield, Ill., September 8, and is now running regularly.

H. K. PORTER & Co. in Pittsburgh, have received a number of orders lately for small locomotives or motors for street and suburban railroads.

THE Morse Bridge Works in Youngstown, O., were burned down recently, the buildings being destroyed and the tools badly damaged. They will be rebuilt at once.

THE Keystone Bridge Company in Pittsburgh has taken the contract for a new bridge over the Connecticut River at Lyme, Conn., for the New York, New Haven & Hartford road, to be completed by August of next year. The bridge will rest on the old piers, the same as the present bridge.

THE Cooke Locomotive Works at Paterson, N. J., are preparing to build ten rotary steam snow-shovels, two for the Union Pacific, four for the Northern Pacific, one for the Colorado Midland one for the Oregon Railway & Navigation Co., one for the Central Pacific and one for sale.

E. P. ALLIS & Co. in Milwaukee, Wis., are building a quadruple-expansion stationary engine for the Warren Manufacturing Company at Warren, R I. This engine has cylinders 24, 36, 52½ and 64½ in. diameter, all being 72-in. stroke. It is expected to work up to about 2,000 H. P. in use.

THE Burton Stock Car Company in Boston has recently contracted to carry 30,000 head of stock from the ranches to Kansas City over the Missouri Pacific road. The company has recently leased 50 new cars of its patent (built by the Carlisle Manufacturing Company at Carlisle, Pa.) to the St. Louis, Arkansas & Texas road for five years.

CONTRACTS will soon be let for a new steamboat to be run between Detroit and Cleveland for the Detroit & Cleveland Steam Navigation Company. The new boat is intended for passenger traffic chiefly, and will be 270 ft. long with steel hull. She will have a beam engine with cylinder 60 in. diameter and 12 ft. stroke and surface condensers. The paddle-wheels will be iron feathering wheels of Morgan's patent.

THE Berlin Iron Bridge Company at East Berlin, Conn., has a large number of contracts on hand, and its shops are exceedingly busy. The contracts are both for railroad and highway bridges, among the former being seven four-track bridges for the New York, New Haven & Hartford road; among the latter are spans of 240, 220, 200 and 175 ft. The company has also a large number of contracts for iron building and roofing work.

THE Grant Locomotive Works in Paterson, N. J., were partly destroyed by fire September 7, the building containing the erecting shop and principal machine shop having been destroyed by fire. The machinery in the building was all badly damaged, and part of it ruined. In the loft of the building was stored a great number of old patterns, including those used in the works for many years past; all of these were destroyed. The foundry, blacksmith and boiler shops, tank and tender shops and other parts of the works escaped.

THE Boston & Albany shops at Allston, Mass., have recently turned out several new cars. They are each 57½ ft. long, weigh 51,000 pounds and seat 78 passengers. They are painted the standard color of the Boston & Albany, and, like all recently built cars of the road, are covered by the Mann roof. They are finished inside in solid mahogany, highly polished and upholstered in old gold. Each is provided with a water-closet, but the usual closet for the heater is absent, as it is proposed to heat the cars with steam from the locomotive. The cars are also wired for electric lightning, but handsome bracket oil lamps are also provided. The trucks are provided with Adams' patent dust guard.

Proceedings of Societies.

Civil Engineers' Club of Cleveland.

AT the August meeting in Cleveland, O., President Whitelaw in the chair, a long and interesting paper was read by the venerable John H. Sargent, who made the original surveys for what is now part of the Lake Shore & Michigan Southern road from Cleveland, west. Mr. Sargent gave many reminiscences of the way in which work was done at that early day, and of his experiences as a pioneer in the location and building of Western railroads.

Mr. H. C. Thompson read an interesting paper on the Method of Building Additional Tracks to a Single-track Railroad already in Operation.

Mr. C. P. Leland spoke of the manner in which a second track was laid on the Lake Shore road from Buffalo to Cleveland in a single year, under the direction of Mr. Collins, which he considered a great feat in engineering.

After a short general discussion, the Club adjourned.

Boston Electric Club.

THIS Club has been organized in Boston, with over 100 members and the following officers: President, Frank Ridlon; Vice-Presidents, W. B. Hosmer, Frank A Houston, N. J. Hammer, Henry J. Pettingill; Secretary, Allen V. Garratt; Treasurer, Herbert H. Eustis.

The Club will meet on the first Monday evening of every month, when scientific papers will be read having special reference to electricity. Exhibits of inventions and other things which would particularly interest its members will be given from time to time at the Club Rooms, which are located at No. 66 Boylston Street. The rooms will be used for social purposes as well as for meetings.

A Proposed Engineers' Club.

A CIRCULAR has been issued, signed by some 20 prominent gentlemen, asking for opinions on the question of establishing in New York a social club for engineers, "which will bring the members of the several branches of the engineering profession into closer personal relations and afford a convenient headquarters for non-resident engineers during their visits to this city."

The signers of the circular propose to call a meeting for organization as soon as 250 eligible persons (in good standing as members of representative engineering societies) have agreed to join. The name, accommodations to be provided, etc., cannot be fully decided on till that time.

The formation of an engineering library is also part of the project.

Mr. James C. Bayles (Box 1415, New York City) is acting as Secretary of the Committee issuing the circular.

Western Railway Club.

THE first meeting for the season was held in Chicago, September 21. The first subject was Contract Work in Railroad Shops, on which a paper was read by Mr. F. D. Casanave. This paper was freely discussed by members.

The subject of Car Couplers w·s then taken up, and the discussion was opened by Mr. G. W. Rhodes, who gave a brief history of the Coupler Question and an account of the action of the Master Car-Builders' Association. The discussion was

continued by Messrs. Verbryck, Wadsworth, Perry, W. A. Smith, Pierce, Mackenzie, Forsyth and others.

The Club then elected officers for the ensuing year as follows: President, Godfrey W. Rhodes; Vice-President, B. K. Verbryck; Treasurer, W. B. Snow; Secretary, Angus Sinclair.

Master Car & Locomotive Painters' Association.

THE annual convention opened in New York, September 14. The Secretary reported 98 active and 20 honorary members. The following officers were elected: President, Samuel Brown, Old Colony; First Vice-President, M. W. Stines, Barney & Smith Manufacturing Company; Second Vice-President, J. J. Murphy, Louisville & Nashville; Secretary and Treasurer, Robert McKeon, New York, Pennsylvania & Ohio.

The session was mainly occupied by a discussion on the use of raw linseed oil with japan.

In the evening, the members attended a reception given them by the Painters & Decorators' Association of New York.

On the second day, papers were read and discussed on the Drying and Binding Qualities of Japan; the Quantity of Paint Required per Square Yard of Surface; the Management of the Railroad Paint Shop, and Priming Coat for Locomotive and Tank Work. The discussions were generally joined in by the members present.

On the third day, the discussions and papers were on the Best Method of Mixing and Grinding Car Body Colors; Effect of Iron Rust on Paint, and on Painting the Inside of Tender Tanks.

The Association has appointed a new Standing Committee, whose business is to answer inquiries made by members. It is called the Committee on Information and is composed of Messrs. Robert McKeon, F. M. Widser, B. B. Hodges and W. C. Fitch.

New England Railroad Club.

THE first meeting of the season was held at the Quincy House, Boston, on the evening of September 14. This meeting was devoted to the annual dinner of the club, and about 130 members and invited guests were present, with President Lauder in the chair.

After the dinner had been disposed of, President Lauder called the company to order and said he was very glad to see so auspicious an opening of the regular meetings of the Club for the fall and winter. He never saw so large an attendance before at any meeting of the Club, and he hoped that the example shown at putting in solid work would be followed by similar work at other meetings. In closing, Mr. Lauder said that Mr. J. A. Coleman, of Providence, had consented to read a paper on the Rise of the Railroads, and the Influence of Mechanical and Other Organizations on Their Progress.

Mr. Coleman spoke of his recent visit to England, the birthplace of railroads. The genius and perseverance of George Stephenson and his early inventions and triumphs were detailed at some length, and after showing that tramways, run by horses, were in use in England as early as 1750 or 1760, Mr. Coleman referred to the early history of railroads in this country, and rapidly sketched their wonderful growth up to the present year, closing by speaking briefly of the influence of such associations as the New England Railroad Club.

Miss Ada D. Noyes, of Lowell, recited a sketch entitled "Too Late for the Train," and was followed by ex-Gov. Smyth, of New Hampshire, who spoke of the important interests represented by the gentlemen before him, and the necessity of having men with brains in their ranks.

General Superintendent Jackson, of the New York & New England Railroad, spoke of the necessity of having men in the railroad service who take pride in their profession.

Mr. George H. Conant was called upon to speak for the ladies, and he was followed by Miss Noyes, who gave another recitation that received hearty applausa.

Mr. Shinn, Mr. Forney, Mr. Lewis and others, spoke briefly, and the exercise closed soon after 10 o'clock.

American Society of Civil Engineers.

A REGULAR meeting was held on the evening of September 7 at the Society's house in New York. Mr. C. C. Schneider was called to the chair.

Written discussions on Inspection and Maintenance of Bridges were presented by W. S. Lincoln and by R. A. Shaler, and read by the Secretary.

A letter was also read from Fred. C. Weir, Cincinnati, describing some Howe-truss bridges on the railroad between St. Petersburg and Moscow, Russia. These bridges were planned in 1840, and work superintended by an American. The timber used in them was planed and burnetized. In 1861, they were inspected by Mr. Harris, an old Massachusetts bridge builder, who reported that not a rotten timber was found.

Nine lithographic copies of the plans of these bridges were exhibited.

The following elections were announced: *Members*, Calvin Harlow Allen, New York; Robert Bunker Coleman Bement, St. Paul, Minn.; Peter Franklin Bredlinger, Pottsville, Pa.; Alba Fisk Brown, Pittsburgh, Pa.; George Devin, Pittsburgh, Pa.; Roscoe Edwin Farnham, Chicago; Charles Hallett, Graham, New York; Charles Harlowe, Chicago; David Christian Henny, Cleveland, O.; Edward Willard Howe, Boston; William Dunbar Jenkins, Kansas City, Mo.; Horace Greeley Johnston, Salina, Kan.; Alfred Potter Kirtland, Blairsville, Pa.; Frederick Nash Owen, New York; Alfred Holden Simpson, Newport News, Va.; Otto Frederick Sonne, Orrick, Mo.; William Starling, Greenville, Miss.; Alfred Thomas Tomlinson, Badger, Col.; Francis Stuart Williamson, Jersey City, N. J.

Juniors.—Julius Baier, St. Louis, Mo.; Gilbert James Bell, Orrick, Mo.; Frank Beresford, Cincinnati, O.; Edwin Mitchell, Norfolk, Va.; George Richard Sikes, Philadelphia; George Oliver Tenney, Decatur, Ala.; Yoshichika Wada, Orrick, Mo.

It was announced that subscriptions to the building fund now amount to $8,087. A special committee has been appointed, consisting of Messrs. T. C. Clark, D. J. Whittemore and J. M. Wilson, to solicit further subscriptions from members and others who may feel interested in the Society.

A REGULAR meeting was held at the Society's house in New York, September 21. Colonel W. H. Paine was called to the chair.

A number of photographs of the Poughkeepsie Bridge and also of the Kentucky & Indiana Bridge were on the Secretary's table.

A paper on Excessive Rainfalls by Mr. S. Whinery was read. The author instanced rainfalls at Somerset, Ky., near Meridian, Miss., and at Alexandria, La. It is to be regretted that in most cases of extraordinary rainfalls only chance data are preserved, and there is no official record. The use of good self-registering gauges by the Signal Service is recommended.

A discussion followed. Mr. Flagg mentioned a storm at St. Kitts, West Indies, in 1885, when over 30 in. of rain fell in 6 hours.

Mr. Anderson (of the Public Works Department of India) said that in Malabar a storm had occurred in which 25 in. of rain fell in 24 hours, nearly all of it in 15 hours. This rain extended over 100 square miles.

A written discussion on the Kentucky & Indiana Bridge by Mr. J. W. Schaub, was read by the Secretary. This was followed by a discussion, in which Messrs. Cooper, Emery and others took part.

Master Mechanics' Association.

THE following circulars have been issued from the office of Secretary Angus Sinclair, No. 175 Dearborn Street, Chicago:

CONCERNING CIRCULARS OF INQUIRY.

In sending out circulars of investigation, the Advisory Committee would remind the members that upon the character of the answers returned to the circulars, must, to a great extent, depend the value of the reports for next Convention. Every year, committees have had reason to make complaints of the limited number of replies returned in answer to the circular of inquiry. We urgently call upon the members to make complaint of this kind unnecessary in the future. It is very desirable that good reports should be prepared, but the data for the same ought to be supplied by individual members.

There are few members of the Association who have not facts drawn from their practice to record, which would be of value to the whole railroad world; and in numerous instances, they are kept back through mistaken modesty, or in the belief that they might not be properly appreciated. That is a mistake. Anything a mechanical man is doing, which he has not seen others doing in the same way, will excite interest. We would then earnestly press upon members not to pigeon-hole the circulars of inquiry, but to answer the questions as satisfactorily as possible, and return them promptly to the proper destination.

SPRINGS AND EQUALIZERS.

The subject of springs and equalizers is one that may be taken up from different points of view. It occurs to your Committee, however, that the principal point for them to report on wou'd be, if possible, to establish uniformity in the size of steel for plates, and the length of spring best adapted for driver and engine trucks of the ordinary American engines. With this point in view, it is respectfully requested that each member make as full a report as possib'e, accompanying the same with drawings.

1. What size of steel do you consider gives the best results in locomotive-driver and engine-truck springs? It is assumed that crucible cast-steel is used, but if not, please state what kind of steel you recommend.

2. What length of spring, from center to center of hangers, gives the best results both for driver and engine-truck springs?

3. How many plates should be in each driving spring, to carry an eight-wheel passenger engine, with about 56,000 lbs. on the driving wheels, or about 14,000 lbs. on each driver?

4. How many plates for engine-truck springs with about 34,000 lbs. on truck wheels?

5. How much camber or set should such driving and truck springs have when free? How much when loaded with the above weights?

6. Do you recommend the same size of steel and distance between hangers for all classes of engines, and regulate the capacity by the number of plates, or do you have different sizes of steel to change the capacity? If the latter, please state the advantages of that plan.

7. Please state your preference for the attachment of the spring hanger—slot or stirrup—and give your reasons for the preference.

8. What is your method of applying bands? What size of iron do you use? And is there any advantage in making the bands wider at the bottom than at the top?

9. Have you had any experience in the use of bandless springs.

10. What is your practice in regard to equalizers for driving springs? Do you recommend a solid bar or one slotted for a post? Please send sketch or blue print showing equalizers and attachment, both in the center and to spring.

11. What is your practice in regard to engine truck equalizers? Please send sketch or blue print of equalizer and attachment to truck box and spring.

12. Please send sketch, or blue print, of what you would recommend as the best form of equalizer and attachment for a Mogul or two-wheel truck.

John Mackenzie,
Wm. Swanston, } Committee.
J. S. Porter,

Answers to be sent to John Mackenzie, Superintendent of Motive Power, New York. Chicago & St. Louis Railway, Cleveland, Ohio.

PERSONALS.

Commander G. H. Wadleigh, U. S. N., has been ordered to duty as Navigation Officer at the Boston Navy Yard.

Assistant Engineer E. T. Warburton, U. S. N., has been ordered to special duty at the Union Iron Works, San Francisco.

Ensign Joseph L. Jayne, U. S. N., has been ordered to duty at Johns Hopkins University in Baltimore.

Lieutenant William P. Potter, U. S. N., has been ordered to duty at the Naval Academy at Annapolis.

Ensign William L. Howard, U. S. N., has been ordered to special duty in the Bureau of Navigation.

Mr. John Player has been appointed Superintendent of Motive Power of the Wisconsin Central Railroad.

Mr. F. G. Brooks is Chief Engineer of the projected Forest City & Watertown line in Dakota.

Mr. H. L. Cooper has resigned his position as Master Mechanic of the New York, Pennsylvania & Ohio, and will hereafter reside in Chicago.

Assistant Engineer Ira N. Hollis, U. S. N., has been ordered to special duty at the Manual Training School, Chicago.

Assistant Engineer H. W. Spangler, U. S. N., has been ordered to duty at the University of Pennsylvania in Philadelphia.

Assistant Naval Constructor A. W. Stahl, U. S. N., has been ordered to special duty at the shipyard of Cramp & Sons, Philadelphia.

Mr. J. C. Chase has been appointed City Engineer of Wilmington, N. C. He was recently Superintendent of the water works.

Mr. J. Van Smith is appointed Superintendent of the Philadelphia Division of the Baltimore & Ohio Railroad, in place of Mr. Wilbert Irwin, resigned.

Mr. John M. Marstellar is appointed Master Mechanic at Martinsburg, W. Va., shops, succeeding Mr. William Edwards, resigned.

Mr. Edwin F. Jones, formerly with the Louisville & Nashville, has been appointed Chief Engineer of the Buena Vista & Ellaville Railroad in Georgia.

Mr. Peter Rockwell has been appointed General Road-Master of the Union Pacific Railway, in place of Mr. Joseph McLeod, who has resigned.

Mr. A. B. Paine is Chief Engineer of the projected Poughkeepsie, Hartford & New England Railroad, and his headquarters are at Poughkeepsie, N. Y., for the present.

Professor G. Brown Goode, Assistant Director of the National Museum, has been appointed Commissioner of Fish and Fisheries, vice Professor S. F. Baird, deceased.

Mr. Frank C. Smith has been appointed Master Mechanic of the Peoria, Decatur & Evansville Railroad, with office at Mattoon, Illinois.

Mr. B. H. Bryant has been appointed Chief Engineer of the Colorado Midland Railroad, with office at Colorado Springs, Colorado.

Mr. M. V. Smith, of the Pittsburgh iron firm of Smith & Laughlan, has been appointed Consulting Engineer of the East Chicago Rolling Mill Company.

Mr. H. P. Hale has been appointed Engineer of Maintenance of Way of the Toledo Division of the Pennsylvania Company's lines.

Mr. E. St. John, late Assistant General Manager, has been appointed General Manager of the Chicago, Rock Island & Pacific Railroad.

Mr. T. F. Whittlesey is appointed Superintendent of the Kalamazoo Division of the Lake Shore & Michigan Southern road, in place of M. E. Wattles, resigned.

Mr. M. E. Wattles, late with the Lake Shore & Michigan Southern, has been appointed General Superintendent of the Chicago, Kansas & Nebraska.

The late Alfred Krupp is to be commemorated by a statue to cost $15,000, to be erected in the Market-place at Essen, Prussia.

Mr. W. Alvey has been appointed General Agent of the Baltimore & Ohio Railroad at Washington, succeeding Mr. J. F. Legge, promoted.

Mr. S. R. Callaway, formerly Vice-President and General Manager of the Union Pacific, has been chosen President of the Toledo, St. Louis & Kansas City Railroad Company.

O. H. P. Cornell, of Albany, is the Republican candidate for State Engineer of New York. He is a civil engineer by profession and a son of the late Ezra Cornell, founder of Cornell University.

Mr. J. F. Legge, General Agent of the Baltimore & Ohio Railroad at Washington, has been appointed Superintendent of the Western Division, Main Stem, succeeding Mr. C. Dunlap, resigned, dating from Sept. 15, 1887.

Mr. G. A. Thompson, late Roadmaster of the Western Division of the New York, Lake Erie & Western Railroad, has been appointed Superintendent of the Rochester Division of the same road.

Mr. H. G. Manning, formerly on the Boston & Albany road, and recently with the estate of F. W. Richardson, has accepted a position with the Hinkley Locomotive Company, of Boston.

S. W. Robinson, Professor of Mechanical Engineering, Ohio State University, has just terminated an engagement as Consulting Engineer of the Atlantic & Pacific Railroad, with a report upon the iron bridges of the road.

Mr. S. F. Woods, Chief Clerk in the office of Superintendent of Motive Power Rhodes, of the Chicago, Burlington & Quincy, has accepted a position with the Eames Vacuum Brake Company.

Mr. O. W. Stager has been appointed Assistant Superintendent of the Main Line Division, Philadelphia & Reading Railroad, with office at Reading, Pa. He has been Superintendent of Telegraph for many years.

Mr. William E. Green has been appointed Assistant Superintendent of the Chicago, Burlington & Northern Railroad, with office at La Crosse, Wisconsin. He was recently Roadmaster of the road.

Mr. A. Kimball, for 30 years connected with the Chicago, Rock Island & Pacific road, has retired from the active duties of Vice-President, but has consented to remain with the Company as Assistant to the President.

Mr. G. M. Farley is appointed Engineer of Maintenance of Way of the New York & New England Railroad, with headquarters at Hartford, Conn. He was recently with the Pennsylvania Company.

Mr. John Bogart, Secretary of the American Society of Civil Engineers, is prominently mentioned as a candidate for the office of State Engineer of New York at the coming election.

Professor M. E. Wadsworth, of Colby University, Waterville, Me., has been appointed Principal of the mining school at Houghton, Mich, in place of Professor Albert Williams, resigned.

Mr. A. K. Mansfield has removed his headquarters from Chicago to New York City, where he will continue his business as mechanical engineer, in company with Mr. George L. Mansfield, the firm name being A. K. Mansfield & Co. The removal was made October 1.

Dr. Charles W. Dabney, Jr., who has done much valuable work as State Chemist and Director of the North Carolina Agriculture Experiment Station, has accepted the Presidency of the University of Tennessee, and assumed the directorship of the Agriculture Experimental Station in the same State.

Mr. Arthur S. C. Wurtele has been appointed Deputy State Engineer of New York, in place of John Bogart, resigned. Mr. Wurtele was formerly on the New York Central, and has recently been in the Department of Public Works of New York City.

Mr. Charles E. Emery has resigned his position as Manager and Engineer of the New York Steam Company, but remains Consulting Engineer of the Company. Mr. Emery will devote himself to his practice as consulting engineer and expert.

Mr William J. Murphy, who succeeds Mr. Benjamin Thomas as General Superintendent of the New York, Lake Erie & Western Railroad, has been for many years in the service of the road, working his way up gradually to his present position. For sometime past he has been Superintendent of the Buffalo Division.

NOTES AND NEWS.

Australian Railroads.—The Australian Intercolonial Railroad has just been completed between Adelaide, South Australia, to Melbourne, Victoria, a distance of 508 miles. From Melbourne to Sidney, New South Wales, there is already a line in operation 553 miles in length. From Sidney there is a line under construction to Brisbane, the capital of Queensland, a distance of 500 miles. The railroad system of Australia, however, is very small as yet, compared to the extent of the country.

A Great Granite Shaft.—The Bodwell Granite Company recently took out from its quarries in Maine a granite shaft 115 ft. long, 10 ft. square at the base and weighing 850 tons. It is claimed that this is the largest single quarried stone on record.

An Electric Watchdog.—A resident of Plymouth, Mass., protects his grapevines from fruit thieves in a novel manner. The supports are of wood, but the cross-pieces are of wires insulated from the ground and connected with an induction coil capable of delivering a heavy spark through an inch of air. The other pole of the coil is connected to the ground. Six good-sized bichromate of potash cells furnish electro-motive force for the coil. Short wires hanging among the wines are secured to the large wires, and when any one monkeys with the grapevine while the battery is connected the neighborhood is apt to hear from him. It works every time, and no one comes for a second dose.—*Boston Herald.*

Utilizing the Rhone at Geneva.—Arrangements are in progress to utilize the water power of the River Rhone at Geneva, Switzerland. Under an agreement lately made, the left arm of the river is to be used, the right branch being left entirely clear as an outlet for the lake. The fall obtained is from 5½ to 12 ft., and the quantity of water is estimated at about 4,700 cubic feet per second, at the lowest stage of the river. Six turbines are to be used, from which about 300 H. P. can be obtuined.

An English Ship Canal.—A plan has been proposed in England for giving Birmingham the advantages of a water connection. The plan is to enlarge the present Worcester & Birmingham Canal, make some additions to the work, now existing for the navigation of the Severn River, thus carrying the navigation to Gloucester. At Gloucester, advantage will be taken of the Berkeley Ship Canal, extending to the estuary of the Severn; this will require an extension of about 6 miles to secure a better entrance. The cost of the whole project, including the purchase of the existing canals, is estimated at $10,000,000. Birmingham would be accessible for vessels of 200 tons, and would have the advantage of a water route competion.

An Earthquake Theory.—In certain disturbed regions calcareous rocks full of fissures and caverns may exist to a very great depth from the surface. The subterranean cavities which the infiltration of water has created in such places may, in spite of thr fissures which only allow water and steam to pass slowly and with difficulty, become like boilers or closed receivers containing steam under pressure and water whose boiling boiling corresponds to that pressure. These temperatures and presures increase from one cavity to another with a force and at a measure depending on the depth below the surface.

Now, if two cavities where the pressures are diffierent come into sudden communication, either through the breaking of the partition between them or the enlargement of the fissures which connect them, there would be produced a sudden lowering of pressure in the cavity where it was the higher, and, consequently, the instantaneous transformation into steam of a part of the water contained in it; that is to say, a true explosion, of a violence sufficient to make itself felt.

If we admit an increase of te nperature of 1° for each 30 meters of distance below the surface, such phenomena as are referred to above could be produced at the relatively small depths of 4,000 to 5,000 meters below the surface.—*M. Opperman, in Revue Scientifique.*

New Wheel Lathe.—Messrs. Collier & Co., of Salford, England, have just constructed a lathe specially adapted for turning locomotive wheels after they are fixed on the axle, and it is arranged to turn the sides and tread of the wheel at one setting of the rest. The machine consists of a strong bed which is sunk level with the floor line, so that the wheel can be passed into the lathe without lifting. The headstocks are made proportionately strong to deal with wheels up to 6 ft. diameter whilst fixed on their crank axles, and the spindles are provided with steel anti-friction washers, to prevent end-thrust. The loose headstock is movable on the bed by means of rack and pinion to suit different lengths of axles, and the face plate can be run at the same or different speeds, to enable, if required, a tire to be turned at one face plate whilst a wheel is being bossed at the other. The feed motions are self-contained with the bed, and give two cuts to one revolution of the face plate. The compound rests are provided with double swivels, to enable the sides and treads of wheels to be turned without moving the saddle or rest on the bed.—*The Engineer.*

A Caucasus Railroad.—The question of constructing a railway crossing the principal chain of the Caucasus occupies the attention of the Russian Minister of Public Roads. The termini proposed are, in the north, the Darg-Koch station of the Vladikavkas Railroad, and, in the south, the Gori station of the Transcaucasian Railroad. The engineering difficulties to be encountered in the construction of the railway are immense; but they will be overcome, as others as formidable have been before them. The cost of construction, however, will be enormous. The railroad will only be about 120 miles long, of which about 11 miles will be tunnels, and the expenditure estimated, roundly, at $35,000,000, or $290,000 per mile. As the railroad will be a line of the highest military importance, expense will probably be no consideration.

Purchase of Norwegian Private Railroads.—The question of the Swedish State buying all the private railway lines in that country has, for some time, been on the *tapis*, although no definite decision has been or in all probability will be taken within the first few months. The Norwegian Government is entertaining a similar plan, and a measure to this effect is already before the Norwegian Diet. It proposes to authorize the Government to purchase through a period of three years what shares they can obtain at a certain fixed list of prices. These vary very considerably for the different companies; they are all, and most of them very much, below par. An exception in this respect is the main line, for the private shares of which it is proposed to pay 115 per cent. Should the private

shareholders not respond sufficiently to this offer, the Government will probably have to expropriate the remainder of the shares, a somewhat extreme proceeding, which they hope to avoid. The State already owns a number of shares in all the railroads, having assisted with loans or grants at the building of the railroads; the remaining shares are held by various corporations, etc., and private persons.

Railroad Rates—In the "Nationality and Railroad Policy" of the late Baron Von Weber, published in 1875, occurs the following passage: "It cannot be denied that the rates of railroads form an impenetrable chaos, in which the worst forces of secrecy, discrimination, improper motives, work without restraint, but in which, most of all, false logic has its domain. But, on the other hand, neither can it be denied that all attempts to purify, to organise, and to systematise have had for their sole result to make this chaos still more chaotic. And this is not only because, as pessimist antagonists of the railroads claim, with only partial justice, because the obscurity of the system of rates is not unwelcome to many railroad managements, but simply because it is no more possible to systematise railroad rates than the market prices of bread and meat. The utilization of railroads, whether Government or private roads, is a commercial operation, in which demand and supply, value in use and cost of production play just the same part as in every other commercial operation. Now, since the cost of performing the transportation everywhere varies like the selling price of goods, the demand and supply of transportation, the infinite permutation of these values make any logical and universally just systematisation of the rates, *a priori*, a labor of the Danaids."

Chinese Coinage.—A correspondent of the *Engineer* writes from Canton that copper or brass coins are made in China by pouring molten metal into moulds instead of stamping or impressing the device and superscription on the prepared metal discs by machinery. Very inferior work is the result, and the same correspondent says that it is not unusual for the very men who are engaged in making coins for the Government to go home and make some on their own account in the evening. They are smaller in size and made of baser metal than those made for the Government, but they pass all the same.

English Iron and Steel Production.—For the six months ending June 30, the production of pig-iron in the United Kingdom is reported by the British Iron Trade Association as follows:

	1887.	1886.
Furnaces in blast	407	396
Production, half-year, tons	3,668,115	3,536,774

The increase this year was 131,341 tons, or 3¾ per cent. On June 30 last there were 459 furnaces out of blast.

The statement for Bessemer steel production for the half-year is as follows:

	1887.	1886.
Ingots, tons	915,554	713,337
Rails	445,785	369,929
Other finished products	378,034	....

The other finished products include plates, angles, bars, fish-plates, sleepers, castings, etc.; also blooms and billets.

Honoring an Old Engineer.—It is known that the beautiful stone bridge (1,000 ft. long) which unites the two banks of the Loire at Orleans, and which serves for the passage of the national road from Paris to Toulouse, had for its designer M. Jean Hupeau, who died in 1763, after having held for nine years the title of First Engineer of Bridges and Roads (*Premier Ingénieur des Ponts et Chaussées*).

In 1884, in the course of his researches into the history of the Department of Bridges and Roads, Inspector-General Tarbé de St. Hardouin inquired if the City of Orleans had preserved the memory of M. Hupeau, and if it had given the name of that eminent engineer to any of its streets. The answer was in the negative, but the question was sufficient to call attention to the subject.

A few months since, on motion of a member of the municipal council, M. Chabassiere, a newly opened street, which reaches the right bank of the Loire obliquely, at the entrance to the bridge built in the 18th century, received the name of *Rue Jean Hupeau*, in memory of the First Engineer.—*Annales des Ponts et Chaussées.*

Railroads in Siam.—Hon. Jacob T. Childs, United States Minister to Siam, writes to the State Department as follows: "At last Siam is to have a number of railroads. Last week His Majesty King Chulalongkorn granted to Capt. A. J. Loftus, his hydrographer, and Capt. A. Richelieu, two Europeans who stand high in favor with the King holding prominent positions here, concessions to build five railroads in various parts of Siam and the sole right to lay and operate for 50 years a tramway in the city of Bangkok, the latter of which will necessitate the laying of at least 20 miles of rail. The road from Bangkok to Paknam, at the mouth of the river, will be about 20 miles in length. Captain Loftus left with Prince Devawongse for England to form a company and secure proper parties and capital to build the road. The tramway in the city will be of great benefit and is a most valuable concession. The interior of Siam once opened up by railroads, a great deal of latent wealth will be developed, and they will add largely toward settling up sections that are now lying idle."

Blast Furnaces of the United States.—The *American Manufacturer* says: "Our usual monthly statement, in a condensed form, makes the following showing:

Fuel.	In blast. No.	In blast. Weekly Capacity.	Out of blast. No.	Out of blast. Weekly. Capacity.
Charcoal	79	13,000	99	10,729
Anthracite	130	36,872	72	17,294
Bituminous	143	87,953	70	28,686
Total	352	138,725	241	56,709

"This is the largest capacity reported in blast since these reports were first begun in the *Manufacturer* in 1872.

"Compared with a month ago, there is one less charcoal furnace in blast and 496 tons capacity at furnaces using charcoal; there are three more anthracite furnaces and 1,594 tons more capacity, while at the bituminous furnaces the number in blast has increased 23, and the capacity 17,098 tons.

"The great increase this month is due, of course, to the resumption of furnaces that were laid idle by reason of the strike in the Connellsville coke region.

"A year ago—September 1, 1886—there were in blast 66 charcoal, 121 anthracite and 132 bituminous furnaces: a total of 719 furnaces, with a total weekly capacity of 121,476 tons."

Baltimore & Ohio Employes' Relief Association.—The July sheet of this Association shows the payment of benefits during the month, as follows:

	No.	Amount.
Accidental deaths	5	$5,000
Accidental injuries	366	4,344
Natural deaths	5	1,850
Sickness	553	8,248
Physicians' bills	189	1,184
Total	1,118	$20,626

The number of benefit payments from the organization of the Association has been 65,209 in all.

New Russian Steel Works.—The construction of iron-clads at Sebastopol and Nicolaeff is exercising considerable influence on the development of iron and steel works and rolling mills in the province of Ekaterinoslav. A little more than two years ago the semi-official Briansk Company increased its capital by nearly $1,250,000 in order to erect new works in the Krivoy Rog District, as a branch establishment to its colossal works at Briansk. The money was subscribed without difficulty, the works commenced, and during the the past winter 1,000 men have been employed day and night hastening their completion, in response to the pressure of the Government and the commencement of rival undertakings by foreign firms. The Krivoy Rog District is believed to contain the richest deposits of iron in the world, and the new Briansk establishment is within 20 miles of the town of Ekaterinoslav, close to the works Messrs. Cockerill are erecting. The works of the Briansk Company are expected to be finished by the end of April. They comprise large, iron-smelting sheds, steel rolling mills, and work-shops for forging and casting. At the outset, the works will be chiefly occupied in manufacturing steel plates for the South Russian iron-clads, and steel rails for the new East Russian railways. Much of the machinery now being erected has been obtained from abroad. The works lie close to the railroad, and are also connected with those at Briansk by canal and river. Their completion and the construction of the other works are expected to exercise a considerable influence not only in the development of Ekaterinoslav, but on the South Russian iron trade generally. Judging by appearances, the iron trade of Russia is rapidly shifting from the Urals and St. Petersburg to the provinces contiguous to the Black Sea, and the development of the southern fleet will hasten this movement. Reports are current that two more iron-clads are to be commenced this year at Sebastopol,

The Belgian International Exhibition.—The Belgian Government is making extensive arrangements for the great International Concourse of Science and Industry, which is fixed to take place at Brussels in 1888. The Director of the Belgian section, accompanied by several members of the general commissariat department, is now going the round of the provinces and appointing local committees in the different industrial centers. The duty of these committees will consist in grouping together the heads of local industries and inducing as many as possible to contribute to the national section. Foreign committees are being organized all over the world.

In this International Concourse the Fortieth Division will have charge of all matters relating to: 1. Civil Engineering and Public Works; 2, Architecture; 3, Materials of Construction.

Under the first head, designated as 40A, will be included all plans and designs for roads, canals and other public works; descriptions of works completed and all matters marking real progress in construction.

Under the second head—40B—will be included plans and designs for buildings of all kinds; special attention will be paid to the question of dwellings for workingmen.

The third subdivision—40C—will include tests of materials—steel, iron, stone, brick, wood etc., etc.; apparatus for tests; studies on cements, beton, etc.

The officers of Committee No. 40 are: President, M. Theodore Lamal, Brussels; Vice-Presidents, M. Wynand Janssens, Brussels, and M. Louis Berger, Schaerbeck; Secretaries, M. Desaunois, Brussels, M. Joniaux, Brussels, and M. Jean Laurent Hasse, Antwerp.

Subdivision 40A—President, M. T. Lamal; Vice-Presidents, MM. Cousin, Charles Legrand, de Raeve and Charles Van Mierlo; Secretary, M. Desaunois.

Subdivision 40B.—President, M. Wynand Janssens; Vice-Presidents, MM. Frans Baekelmans, J. Brunfaut, Ad. Pauli and Van Ysendyck; Secretaries, MM. Jean Laurent Hasse and Heyninx.

Subdivision 40C.—President, M. Louis Berger; Vice-Presidents, MM. de Matthys, Velge, Zimmer and Wolters; Secretaries, MM. Joniaux and Monnoyer.

M. Laval, on behalf of the Committee, issues a general invitation to engineers, architects and all others interested to attend and take part in the proceedings of the International Concourse.

The Mercantile Shipping of the World.—The figures given in *Lloyd's Universal Register* for 1887 are the basis of the following estimate of the total number of ships in existence at the close of 1886:

Material.	No. of Vessels.	Tonnage.
STEAMERS.		
Iron	8,198	8,911,406
Steel	770	1,206,962
Composite	109	32,820
Wood	892	380,655
Total Steamers	9,969	10,531,843
SAILING VESSELS.		
Iron	1,959	2,078,777
Steel	82	102,519
Composite	161	126,651
Wood	22,953	8,104,060
Total Sailing Vessels	25,155	10,411,807
Grand total	35,124	20,943,650

This does not include vessels of less than 100 tons, which are not included in the register.

The number of vessels owned in the leading mercantile countries of the world were:

	Steamers.		Sailing Vessels	
	No. of Steamers	Gross Tonnage.	Number.	Gross Tonnage.
Great Britain:				
United Kingdom	5,057	6,169,065	4,881	2,846,148
Colonies	735	426,806	2,559	1,097,147
Total	5,792	6,595,871	7,440	3,943,295
France	509	742,662	1,082	286,695
Germany	579	654,814	1,678	769,997
United States of America	400	503,677	3,427	1,530,490
Spain	401	356,912	725	150,113
Italy	173	230,342	1,679	712,857
Netherlands	152	175,476	514	211,762
Russia	212	153,329	944	271,849
Sweden	437	158,788	1,079	312,871
Denmark	200	140,009	648	125,189
Norway	287	142,185	3,200	1,305,337
Austria	123	145,511	350	176,821

The United States is second in number of sailing vessels, but fourth in that of steamers. Norway, which is third in the number of sailing vessels, is eleventh on the steamer list.

This list includes sea-going vessels, whether employed in coasting or trans-ocean trade, but does not include river boats and vessels employed on inland waters. It does not include war vessels.

The total number of vessels built during 1886 was 584, and their total tonnage 563 082. Of these, 315, of a total of 357,566 tons, were steamers, and 269, having a total tonnage of 205,526, were sailing vessels. Of the vessels built 197 were of iron; 179 of steel; 6 composite; and 202 of wood. The average tonnage of the iron and steel vessels was nearly three times that of the wooden ships.

The Naval War College.—The session of the Naval War College was formally opened on Coaster's Harbor Island on September 5. The official programme for the present course requires that the session shall end December 22. There will be two lectures each day, except Saturday and Sunday, as follows:

September: Naval Gunnery, treated with Special Reference to the Influence of the Gun upon Naval Tactics, by Lieutenant J. F. Meigs, 18 lectures.

Naval Tactics and Current Theories Respecting Them, by Commander W. B. Hoff 8 lectures.

Duties of General Staff, by Lieutenant C. C. Rogers, 4 lectures.

International Law, by Prof. J. R. Soley, 8 lectures.

October: International Law, by Professor J. R. Soley, 12 lectures.

Tactics of the Gun, by Lieutenant J. F. Meigs, 4 lectures.

Tactics of the Torpedo, by Lieutenant D. Kennedy, 3 lectures.

Naval History, by Captain A. T. Mahan, 10 lectures.

Coast and Defense, by Lieutenant C. G. Calkins, 4 lectures.

November: Coast Defenses, by Lieutenant C. G. Calkins, 8 lectures.

Defenses of the Seacoast of the United States, by General H. L. Abbot, U. S. Engineers, 5 lectures.

Naval History, by Captain A. T. Mahan, 8 lectures.

Military History, Strategy and Tactics, by Lieutenant T. H. Bliss, U. S. Army, 12 lectures.

Preservation and Care of Iron Ships and Injuries, by Assistant Naval Constructor R. Gatewood, 4 lectures.

Naval War Game, by Lieutenant McCarty Little, 6 lectures.

December: Naval Hygiene, by Medical Director R. C. Dean, 6 lectures.

Military History, etc., by Lieutenant T. H. Bliss, U. S. Army, 12 lectures.

Present Condition of Commerce and Commercial Routes between Europe and the Pacific, with an estimate of the effect produced upon them by a trans-isthmian canal, including a view of the Military and Political Conditions of the Pacific, Gulf of Mexico and Caribbean Sea, by Lieutenant-Commander C. H. Stockton, 6 lectures.

Natural Gas and Oil in the West.—The sinking of a large number of test holes for natural gas and oil in various parts of Illinois, Missouri, Kansas, Iowa, Texas, Colorado, Arkansas and Nebraska will determine in the near future the extent and value of these deposits. Thus far, the results in most of the States named have not been encouraging. Outside of the 20 or more counties south of the Wabash River in Indiana, and west of Indiana, nothing worth mentioning has been discovered. And if the opinions of experts are worthy of consideration, the productive territory in Indiana and Ohio has been quite thoroughly determined. Outside the territory mentioned the Trenton limestone either comes too near the surface, or the other conditions which appear to be necessary for the finding of large quantities of gas do not exist. A considerable amount of drilling in Kentucky has failed of its object, with the possible exception of the recently reported strike 25 miles down the Ohio River from Louisville.

From various parts of Illinois, particularly the central portion, come almost daily reports of the discovery of natural gas in shallow wells ranging from 50 to 200 ft. in depth. Whether this gas comes from decaying drift or through fissures from a carboniferous formation below the drift is a question not yet determined. These shallow deposits appear to be particularly plentiful in Champaign, Coles, De Witt and Tazewell Counties. It is certain, however, that the deep wells at Jacksonville, Beardstown, Springfield and Shelbyville have not revealed the presence of gas in commercially valuable quantities. Deep holes are being put down at Decatur, Charleston, Mattoon, near Pekin, and at a number of other places, and the results of these tests will be watched with a great deal of interest. The deep well sunk by the manufacturers of St. Louis near Edwardsville, Madison County, is down 1,685 ft., and up to this writing is unproductive. It

may be said, therefore, that, aside from the wells at Litchfield, the drill has failed to find large bodies of gas or oil in Illinois.

The results in Missouri have not been any more encouraging than in Illinois. In the southwestern part of the State five or six deep wells have turned out dry holes. At a dozen or more places—notably St. Charles, Mexico, Palmyra and Sedalia—test holes are now being put down. At Fort Smith, Ark., a local company has been organized to drill a 2,000-ft. well, and in Texas a score or more of wells are approaching completion. From Iowa come reports of surface gas, but we are unable to learn of anything very large or valuable. In Eastern Kansas there are several places where natural gas is utilized for heating and manufacturing purposes. The Colorado oil fields have been worked in a mild way for nearly 15 years, and the recent discoveries near Fremont are certainly very promising. It is currently reported that the Standard Company has acquired an immense tract of land about Fremont and will at once give the field a thorough test.—*Age of Steel.*

Steamboats in Colombia.—Consul Edmund W. P. Smith, writing to the State Department from Carthagena, Colombia, says: "When I came here the Colombians were buying river steamers in the United States. They never thought of going to England for light-draft, stern-wheel steamers—to a country where there are no navigable streams suited for boats of that class. I must protest that it is not the fault of the Consul that the Columbians now prefer and are giving their orders for English-built boats in preference to those made in the United States.

"Repeated attention was called in reports from this Consulate that the American boats were not giving the satisfaction they should. The English-built boats consume less fuel, cost less and are lighter built. Take the Dique Steamboat Company, that runs light-draft steamers between this port and Honda, the head of navigation on the lower Magdalena River. The first steamer of this company was built in the United States. It could run very fast but consumed an enormous quantity of fuel and carried but a small cargo. The second boat was built in England; it runs as fast as the one built in the United States, consumes half the quantity of fuel and cost just one-half the money paid for the American boat. The result has been that American-built boats are at a discount here, and the English boat-builders are receiving numerous orders.

"Within the past three years the Dique Steamboat Company has purchased three steamers from Yarrow & Co., of London. It is safe to estimate that over $250,000 have been lost to American steamboat-builders within two years by their apparent indifference to the wants of the steamboat trade of Colombia rivers. The Americans know that they can and do build river steamers better than the English, but unfortunately the Colombians don't know it.

"Unquestionably, river steamboat building in the United States is languishing on account of railroad competition. Then why not turn their attention—the steamboat builders—to South American rivers, where there is no opposition by land? On the great Magdalena River nearly 30 river steamers are now plying. Two other rivers in Colombia, almost equal in commercial importance to the Magdalena, namely, the Atrato and Sinu, will soon have lines of steamers operating upon them. A company, heavily subsidized by the Colombian Government, and partly American, will shortly place three steamers on the Atrato and Sinu rivers. This Company, although desiring to have its boats built in the United States, I am afraid will give the contract to an English boat-builder."

Surveys of India.—The Topographical Survey of India has formed a branch of the Government machinery almost ever since the British occupation of the country. Its chief work has been in local surveys and marking boundaries, as was required by the peculiar tenures of land and methods of taxation in use in the country. Other work has been done, however, in special fields, which has been of value in the advancement of geography and of science in general. The special work of this class done last year is summed up by *Indian Engineering* as follows:

"*Himalaya Party*—Continued the operations of the previous years in the topographical survey of the Hill States about Simla, and of the demarcation of the Nepal boundary in Mechi River, 24 miles of which was demarcated, but the erection of pillars was left over to be taken up on completion of the entire line of boundary. The party also undertook to bring up the arrears of mapping connected with the Nepal boundary survey, the Sikkim triangulation and the Darjeeling revisionary and Dahing lands surveys.

"*Afghanistan.*—A good deal of substantial work was carried on during the year under review under the head of Geographical Survey and reconnoissances. It was highly creditable to the officers of the Afghan Boundary Commission that the very large area of 120,000 square miles was surveyed in that country. The entire province of Herat, including the hitherto unknown Taimani and Firozkuhi country was mapped; almost the entire province of Afghan Turkistan, with a large portion of the Haraza country in the vicinity of Bannian was reconnoitered or surveyed; and on the return march of the Commission, all important passes of the Hindoo Koosh were surveyed.

"*Upper Burmah.*—In this country, Captain Hobday, with a small party of surveyors, made a reconnoissance survey round Mandalay and compiled the reconnoissance sketches executed by officers with the Burmah field force. Captain Hobday and a surveyor joined two military expeditions, one to the Kuchin Hills and the second to the southeast of Mandalay. They succeeded in extending triangulation southward as far as latitude 21 and in surveying an area of 150 miles on the ½-in. scale."

Maps to the number of 210,288 were printed and issued, and a number of large special maps were made for the Colonial Exhibition in London.

Rapid Transit in New York.—The latest Rapid Transit Commission appointed in New York City has completed its labors and submitted a report to Mayor Hewitt, urging the inability of the present elevated roads to carry the traffic, and recommending the building of a via uct line through the blocks. In opening their report the Commissioners say:

"The petition to Your Honor upon which our appointment was made asks for a steam railroad from a point on the easterly line of Broadway, near the City Hall Park, to a point of junction with the authorized line of the New York Underground Railroad Company south of Fourteenth Street.

"We are prohibited by the express terms of the law from extending such road in either direction necessary to give rapid transit. In this we are confirmed by the opinion of the Counsel to the Corporation. We accordingly decline to accede to the request."

After quoting the law on the subject they continue:

"The growth of the city is so rapid that even now the elevated roads can no longer carry comfortably the number of passengers. The remedy seems to us to be a railroad from Forty-second Street to Wall Street or South Ferry, to be extended northward as travel demands.

"Such a road, to be of service, should be as central and direct as possible, and the trains run at a speed of at least 25 miles per hour.

"We are led to the conclusion that there is but one way to obtain such rapid transit, and that is by the construction of a solid viaduct line through the blocks, as far as possible, and when compelled to cross or follow the lines of streets to be constructed with much greater strength and solidity than the present elevated railroads. Such a viaduct road should be built in accordance with the following conditions:

"The structure should be built through the blocks of brick and stone in the most solid manner. The streets should be crossed by massive steel girders with solid steel floors, having no openings. The track should consist of heavy steel rails on ties laid in an elastic material between floor and ties. There would be no jar or break of continuity of motion in such a structure, and trains could be run at high speed with little noise.

"The stations should be not less than one-half mile apart and long enough for 10 cars. The cars should be as wide as possible.

"Trains should be run by independent motors, and as frequently as on the elevated roads, and at a speed of at least 25 miles per hour, including stops, This would enable the trip to be made:

From Wall Street.	Distance. Miles.	Time Minutes.
To City Hall	½	1¼ to 1½
To Union Square	2	5 to 6
To Madison Square	2½	6 to 7
To Forty-second Street	3½	9 to 10

"As we have already stated, the act prohibits laying out any routes of sufficient length to afford rapid transit. Hence, we have not undertaken to make any estimate of cost of a viaduct line, as the expense of necessary surveys, etc., would be too great for individual citizens to pay out of their own pockets.

"We will say, however, that we have made sufficient examinations to convince us that a viaduct line, such as we have described, can be laid out and built for a sum upon which capital might reasonably be sure of return, and one constantly increasing in amount."

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 45 BROADWAY, NEW YORK.

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Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid	$3 00
Subscription, per annum, Foreign Countries	3 50
Single copies	25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

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NEW YORK, NOVEMBER, 1887.

THE relations of the railroads to the timber production and supply of the United States are the subject of a report issued by the Department of Agriculture, which deserves attention. The question is not a new one, but it is necessarily of great interest, and its importance must increase every year as the demand for lumber increases and the sources of supply are diminished. While the area of untouched timber lands is still great, it must be remembered that the consumption is continually growing, and that the railroads are every year opening up new districts to be stripped by the lumbermen. The care of timber lands and the growth of new timber are questions which will probably become of pressing importance in this country much sooner than is generally anticipated. Forestry as a science is almost unknown here, and anyone who desires to study it must go to Europe for masters and for the results of experience.

The efforts of the Department of Agriculture to awaken interest and to disseminate information on this question are deserving of praise, and it is to be hoped that they will be continued.

THE report on the use of iron and steel ties in Europe, a summary of which is given on another page, is an interesting summary of what has been so far done in the substitution of metal for wood in railroad tracks in the leading European countries. The use of metal ties has made much more progress there than in this country, chiefly because of the comparative scarcity and higher price of lumber.

That ties of iron, and especially of steel, will do good service is generally admitted, and the discussions over their use, from a technical point of view, are limited chiefly to argument as to the best form to be adopted. Economically, however, the question of the use of wood or metal for this purpose is an open one and must be decided specially in each case. In several European countries—especially in Belgium, Holland and Germany—the decision seems to be in favor of the metal tie, which is now gradually supplanting wood both in new construction and in renewals. In England and France the question is an open one yet, and comparatively little has been done, while in Sweden, Russia and Austro-Hungary—all countries with extensive forest resources—hardly anything has been done, and the use of wood is, and will probably remain, universal.

THE peculiar geographical situation of Denmark has forced its railroad engineers to plan several distinct systems of railroad, which could only be connected with each other by crossing arms of the sea whose width and depth forbid all attempts to bridge them. The communication of Copenhagen with the mainland and the general railroad system of Europe is broken up very much as that of New York would be, for instance, if all its business with the interior had to take the Long Island Railroad to Greenport and then cross Long Island Sound to Stonington or New London. How the Danish engineers and their marine advisers have met the problem is told in an interesting article on another page.

While they do not seem to have come to America for advice, it is interesting to note that in many respects they have come pretty near to American practice, while there may be some points in which the difference is worth studying.

The Danish railroad system is not very large, nor is its traffic very heavy, but, in the steam ferries used, it has been provided for in such a way that a much greater business could be handled with little or no increase of the permanent plant on shore. More ferry-boats would really be all the addition needed were the traffic to be doubled.

THE NAVY has, so far, had the larger appropriations and has done more toward adopting modern appliances than the Army. The Ordnance Department of the land service has not been idle, however, and is actively employed in fitting up its heavy-gun factory at the Watervliet Arsenal with the best appliances which its present limited means will permit. At present, only the smaller guns can be made there, but it is to be hoped that heavier tools will be supplied as needed, and a plant equal to making the largest guns required will be brought together.

The Government will not, it is understood, attempt to make its own steel, but will continue to call on the steelmakers of the country for the castings and forgings which are to be finished in its own shops.

FURTHER experiments with the Zalinski dynamite gun tend to show that its range can be considerably increased over that shown in previous public trials. Whether the weight and initial velocity of the projectile will be sufficient to give it accuracy at longer ranges seems hardly to be fully proved as yet, although, in the experiments here referred to, the shots fell close to the mark at a longer range than had been before attempted. The later trials were directed entirely to this point, the shells being loaded with sand instead of dynamite, so that there was no showing made as to the effect of their explosion.

The main objection now made by the opponents of this weapon is that the great length of the gun makes it awkward and unwieldy to handle, especially on shipboard. This does not seem to be an objection of sufficient weight

to stand very seriously in the way of its adoption for the purposes for which it will chiefly be used in warfare. It is not claimed that the gun will supersede those now in use, or that it will do away with the use of gunpowder, either for propelling shells or exploding them in military or naval operations. It has, apparently, established its place as a useful auxiliary to coast batteries and ships' guns and a formidable weapon for attack or defense. There is little doubt that it will play an important part in arming our future coast fortifications.

A PRACTICAL trial of a night torpedo-attack was recently given at Newport, R. I., where the new cruiser *Atlanta* was made the point of attack for the other vessels of the Navy there assembled. Torpedoes were not brought into actual use, of course, as the Navy could hardly afford to blow up the latest addition to its numbers, but the methods to be employed in carrying out and resisting an attempt to disable or destroy a hostile vessel were well and practically illustrated. In this case, the *Atlanta* came out the best, its officers and crew being able to detect every approach of the enemy and to take the necessary steps to meet it with the appliances with which the ship is furnished. The only thing lacking to the completeness of the trial was the presence of one or two completely equipped torpedo-boats of the modern pattern.

The most prominent feature in this sham battle was, perhaps, the usefulness of the electric search-lights which were, on this occasion, fully tried for the first time in this country. These lights, it would seem, are fully shown to be really indispensable to the modern warship, if it is not to be at the mercy of apparently insignificant antagonists. Their use is only another proof of what a complicated machine such a ship has grown to be. The old fighting naval officer is now a comparatively insignificant person on board a ship which must be managed largely by engineers, and on which an expert electrician is almost as important as a skilful gunner or an experienced navigator.

THE change of control of the Baltimore & Ohio Railroad, which has been effected in the past month, is really one of the most notable railroad events of the year. The Baltimore ownership, represented and dominated by the late John W. Garrett, and by his son and successor in lesser measure, has so long controlled the company that the possibility of a change has hardly been considered, and when it was announced early in the year that negotiations were in progress for the sale of a majority of the stock, the statement was received with incredulity, especially when the parties to whom it was to be made were mentioned.

The first negotiations fell through, as had been generally anticipated, but at the right moment the transaction was taken up and completed by a syndicate of bankers, whose composition leads to a general belief that the line will be practically managed in the interest of the Pennsylvania Railroad. This belief is certainly well founded, at least to the extent that the Baltimore & Ohio, while nominally remaining an independent line, will never again be found in active conflict with the Pennsylvania. How much this means those who are familiar with railroad history for the past 20 years will appreciate.

While it is not intended to say anything here of the general policy and methods of the elder Garrett, it may be said that, in an engineering sense, there may, and very likely will, be a distinct gain to the road in a change of management. The Baltimore & Ohio was originally the work of some of the greatest engineers which this country has produced, but in later years it has been distinguished by an obstinate conservatism, which continually opposed all new methods and was not willing to concede that any change could be for the better. This was supplemented by a system which left no room for individuality in subordinate officers, and made every department of the road absolutely subject to the will of the chief executive in the smallest details.

Under such a system men of ability do not often take positions and do not hold them long. While the old management of the company has done some excellent things, it failed entirely in others, and the road has not been well managed from an engineering point of view for many years past. It is to be hoped that new men will mean new methods in this case, and a general improvement.

ONE result of the change of control of the Baltimore & Ohio Railroad has been the transfer of the telegraph system built up at great expense by its managers to the Western Union Company. This removes the only considerable opposition which the Western Union has had, and leaves that company practically alone in the field.

This is to be regretted for many reasons, and will probably give a great impulse to the movement for a Government telegraph system as the only practicable, if not the best, means of escape from the present monopoly.

It is true that a single company can work the telegraph lines of the country more economically than several companies more or less in competition, and its advocates therefore claim that it can afford to do the business much better with more satisfaction to the public.

It is also true, however, that the public is not at all satisfied to see so indispensable an agency as the telegraph entirely in the hands of one corporation—especially when that comporation is controlled by a man who is generally and profoundly distrusted.

THE accident at Kouts station on the Chicago & Atlantic road on October 11, was, apparently, due to the absence or failure of signals to warn any train which might be approaching from the rear a passenger train which had been stopped in an unusual place by a slight breakage of the engine. It is stated that there was a distant signal some 1,500 ft. away from the water-tank where the collision took place, and that a brakeman on the disabled train pulled the lever by which this signal was operated. Whether the connection was broken or the semaphore out of order, or whether the engineer of the second train failed to see the signal, does not clearly appear from the published accounts of the collision; no other attempt was made to give warning, and the collision occurred in a very short time after the first train stopped.

The consequences, apparently, would not have been very serious, had not the wreck caught fire from the car stoves. In it nine persons were killed, all of whom would probably have been saved, had it not been for the fire. The wreck would have resulted only in slight injuries to nine or ten persons had it not been for the stoves, and would have passed almost without general notice.

In this case, therefore, the loss of life was due directly

to the stoves in the wrecked cars. The breaking up of the cars, however, which upset the stoves and liberated the fires which they held, was due to their imperfect construction, and might have been prevented by methods of building, to which reference has heretofore been made in our columns. In fact, the sleeping-car, which was at the rear end of the train and so received the full force of the collision, was but little damaged by the shock. It was driven forward by the engine which struck it, and crushed the lighter cars in front.

The accident, therefore, is only one more added to the many which have preceded it, which are to be taken as arguments in favor of a method of building cars which will prevent telescoping—the greatest danger in an accident of this kind with the usual pattern of passenger car.

THE accident on the Chicago & Atlantic, with the fatal results following the burning of the wreck, comes early in the season and has given a fresh impetus to the discussion of the car-heating question. The immediate result is an increased popular demand for the abolition of all stoves in the cars, which necessarily involves the introduction of continuous heating, either by steam direct from the locomotive or from a special car provided for the heating apparatus. The inventors of heating apparatus of this kind are, of course, taking advantage of their opportunity, and are presenting the claims of their respective devices energetically and with considerable success.

The present winter will see many advances made in this direction, and quite a number of the different methods of continuous heating will receive extended trials on different roads in active service. The success of these trials will largely determine to what extent the use of steam from the locomotive for heating will be introduced. A severe winter will bring out the weak as well as the strong points of the different systems, and will give a fair opportunity to remedy defects.

It is not at all probable that any one of the continuous steam-heating systems now on trial will be generally introduced to the exclusion of others. All of them have merits, and there are probably several which will come into extensive use. In this connection the action which the Western Railroad Club has taken in starting a movement to secure, if possible, uniformity in couplings for steam pipes on cars is worthy of commendation. Certainly such uniformity is desirable, and it will be easier to secure now than later.

THE New England Roadmasters' Association had a brisk and well-attended meeting at Hartford last month. There are, indeed, many things to be said in favor of distinct associations of this kind, where the members can all understand and appreciate local needs, and where they can be gathered together with comparatively small expenditure of time on travel.

On the other side, however, is the fact that district associations are apt to become too local and provincial and to lack breadth of view and something of that knowledge which, in larger associations, is the result of the friction of opposing ideas.

Perhaps a combination of the two—district and national—would be the best plan for the Roadmasters, as well as for some other associations.

THE fastest tracklaying on record, it is claimed, has been done this past summer on the Montana extension of the St. Paul, Minneapolis & Manitoba Railroad. The total length of this extension is 550 miles, and the track was all laid between April 2 and October 16; a total of 196 days, which gives an average, allowing for bad weather, of fully three miles a day. The heaviest day's work actually done was 8¼ miles; the heaviest week showed an advance of 32½ miles, and the heaviest month—August—115 miles.

The only time when this record has been approached was on the Canadian Pacific, on some of the Western sections.

A LONG and elaborate paper on aluminum bronze as a substitute for steel in the manufacture of heavy guns was read by Mr. Alfred H. Cowles at the October meeting of the Naval Institute. Mr. Cowles is an expert in the use of aluminum and can doubtless present its claims in the best possible light. His paper, however, is presented to an audience skilled in the manufacture and use of heavy guns and will meet with severe criticism. The advocates of steel will not yield their ground to a comparatively untried metal without a struggle.

This is a case, however, in which argument can finally settle nothing, and actual trial will be necessary to decide.

AUTOMATIC CAR-COUPLERS.

THE announcement has been made of the results of the letter-ballot of the Master Car-Builders' Association on the adoption, or rather recommendation, of the Janney—or, as it has since been named, the Master Car-Builders' type of car-coupler. It may be well to explain that it is provided in the constitution of the Association named, that any proposition recommending the adoption of standards of construction must be submitted for discussion at one of the meetings, after which a vote is taken to decide whether the proposition shall be submitted for decision by letter-ballot to all the members. If decided in the affirmative, the Secretary is required to mail to each member a blank ballot and a copy of the proposed recommendation. The ballots must then be filled up, and signed by the members, and remailed to the Secretary, who is authorized to count the ballots, within 60 days from the date they were sent to members. On matters submitted in this way, active members of the Association each have one vote, and representative members—that is, members appointed by a President, General Manager or General Superintendent of a railroad to represent it in the Association—each have one vote, and in addition thereto, one more vote for each full one-thousand cars which are owned by the company he represents.

It may be well to explain still further, that, after discussing the question of automatic couplers for a number of years, the Association referred the subject to its Executive Committee. At the last annual convention held in Minneapolis that Committee made a report with the following recommendation:

> Your Committee feels that the status of the problem at the present time, as here stated, warrants them in making the recommendation that this Association recommend, as a standard form of coupling, the Janney type of coupler; that the Association procure one of the present make of Janney coupler, selection being made by a committee appointed for that purpose, and then all other forms of couplers that will automati-

cally couple to and with this coupler, under all conditions of service, are to be considered as within the Janney type and conforming to the standard of this Association.

After the report of the Committee was read and discussed a resolution "that the recommendation of the Executive Committee be adopted and acted upon" was passed. In accordance with this action the Secretary sent out a circular in which it was said that "at the last convention of the Master Car-Builders' Association it was agreed to submit the following recommendation for decision by letter-ballot.

"That the Janney type of coupler be recommended as a standard of coupling."

A postal card to be used as a ballot, was inclosed with the circular—which contained the question—"are you in favor of the adoption of the Janney type of coupler as the standard of the Association?"—and members were requested to write "yes" or "no" after the question.

In response thereto 109 members out of a total of 242 cast their ballots. Of these 8 were rejected because the members had not paid their dues, as required by the constitution, and one was received too late to be counted. In all there were 668 valid votes cast, 474 in favor of recommending the Janney type of coupler as a standard and 194 opposed to such recommendation. Two-thirds of all the votes cast are required for the adoption of such a measure. It was therefore declared adopted at a meeting of the Executive Committee held on October 13.

In order to carry out the recommendations of the Executive Committee, made in their report on couplers, a sub-committee was appointed at the meeting referred to "to critically examine the different forms of couplers coming within the Master Car-Builders' Type, and report the result of their examination to the Executive Committee."

This brief statement of the action of the Master Car-Builders' Association is given, because it does not seem to be very distinctly understood just what the action has been. It may be added that the Executive Committee decided that what has been known as the "Janney" type of coupler shall hereafter be called the "Master Car-Builders'" type. Those who do not know anything about the kind of coupler referred to can form an idea of what it is if they will hold the right hand with its palm vertical and bend the fingers to approximate to a half-circle, or, perhaps more accurately, a half-hexagon, and extend the thumb. Then reverse the other hand, so that the two palms will face each other, and bend the fingers so that the fingers of the two hands hook into or engage with each other. The part of the coupler which is represented by the fingers of each hand is described in Janney's patent as a "rotary crank," or, more accurately, a rectangular lever pivoted at its angle. By turning on their pivots, two couplers are made to engage and disengage with and from each other. An automatic "catch-lever," or spring-latch is added to lock the arm of the rotary hook when two draw-heads are coupled together. A "guard-arm"—represented by the thumb in the illustration with the hands—is provided, to prevent the hooks from separating laterally from each other and thus becoming disengaged when the cars are coupled together.

In his patent Mr. Janney says: "The essential features of my invention are the rotary hook, guard-arm, which serves also as a guiding-arm, and the catch-lever for holding the arm of the hook."

To get a correct idea of the present status of this subject, it should be known that the constitution of the Master Car-Builders's Association provides that "the action of the Association shall have only a recommendatory character, and shall not be binding upon any of its members or the companies represented in it." The action of the Association, therefore, has been simply to recommend railroad companies to adopt the Master Car-Builders' type of coupler as a standard.

Undoubtedly this will have a great influence on the action of the State Legislatures, railroad commissioners, and the railroad companies of the country. It is doubtful whether any considerable movement would have been made by railroad companies, looking to the adoption of automatic couplers, had it not been for the pressure brought to bear upon them by the Legislatures of different States. In most cases a certain measure of discretion has been left to the railroad commissioners in determining which couplers may and which may not be used. Inasmuch as a very small proportion of the persons who are railroad commissioners have any considerable knowledge of the mechanics of railroads, probably very few of them would feel disposed to assume a position contradictory of or opposed to the conclusion which has been reached by the Master Car-Builders' Association. The need of protection against legal penalties, in case of injury to employés, will make most, if not all railroad companies very loth to adopt any type of coupler which the Association has tacitly condemned by *not* recommending it. For these reasons it seems probable that not many more automatic couplers which are not of the type which has been recommended will be put into service.

The Association has undoubtedly acted wisely in recommending a "type" of coupler and not any one special form. Through the sub-committee which has been appointed it will undoubtedly select some one form of coupler, with which all that belong to the type recommended must couple. This will lead to a process of the survival of the fittest. Yet the importance of adopting some definite forms and proportions for a standard coupler is very apparent. The more or less conflicting and rival inventions and patents are now obstacles to this action, but probably some eliminating or consolidating process will soon remove the difficulties which now stand in the way of adopting such a standard as the interchange of traffic will demand. No matter what special form of coupler is adopted, it is of the utmost importance that it should be well designed and constructed. It is very remarkable how little importance is ordinarily assigned by railroad officers, who are are not mechanics and engineers, to the design of the mechanism to be used on railroads. It is, of course, true that what in patents is called the principle of an invention is of fundamental importance; but an invention with a good principle is often a failure and useless because the practical details and construction have not been properly worked out. The difference in mechanism when well designed is exactly analagous and comparable to the difference between a picture painted by a good artist and the work of a "duffer." You may give each the same subject, or "scheme," or "principle," and the same canvas and colors, and the artist will make a picture which will be a thing of beauty and command a high price, whereas if the paints are manipulated by an incompetent painter, his work will be worth little or nothing. Now, there is an analogous, if not the same, difference

between the work of a good designer of mechanism, and that of a person who has not the kind of ability which comes from natural aptitude, experience and skill in doing such work. The Master Car-Builders have recommended a principle; the important work of reducing that principle to practice still remains to be done.

THE ELEVATED RAILROADS IN NEW YORK.

GREAT complaint is made of the insufficient accommodation now provided for passengers on the New York elevated railroads. The cars are most insufferably and outrageously overcrowded. Passengers complain, the newspapers scold, and the railroad company complacently collects the public's nickels, knowing that the more uncomfortable the people are the greater will be the dividends on their watered stock. The "public-be-damned" policy is the one which apparently has been adopted, and "let the people stand" is Mr. Sage's dictum from which he may think there is no appeal. It has been repeated so often that the company is running all the trains it can, that generally the statement is not questioned. The fact, though, that there are a great many more trains on Third Avenue than there are on Sixth, shows that on the latter line at least it is possible to increase the train service. At any rate, it is important to know in some conclusive way whether the company can or can not afford better accommodation. If it can, it should be compelled to do so—if it cannot, it is a good reason for granting authority for the construction of other roads.

Under the laws of the State of New York it is made the duty of the Board of Railroad Commissioners to investigate just such cases and suggest remedies. The law creating the Board provides that the Commissioners "shall have the general supervision of all railroads and railways, and shall examine the same and keep themselves informed as to their condition and the manner in which they are operated, *with reference to the security and accommodation of the public*."

The law provides further that:

Whenever, in the judgment of the said Board of Railroad Commissioners, after a careful personal examination of the same, it shall appear * * * * that any addition to the rolling stock * * * * or that any change in the mode of operating the road and conducting its business is reasonable and expedient in order to provide for the security, convenience *and accommodation* of the public, the said Board shall give notice and information, in writing, to the corporation, of the improvements and changes which they deem to be proper, and shall give such corporation an opportunity for a full hearing thereon; and if the corporation neglects to make such repairs, improvements and changes, within a reasonable time after such information and hearing, and shall not satisfy said Board that no action is required to be taken by it, the said Board shall present the facts in the case to the Attorney General for his consideration and action; and shall also report the same facts in a special report or in the annual report of said Board to the Legislature.

The present condition of things on the Elevated Railroads is certainly such as the law contemplates should be investigated by the Commissioners. If after investigation they find that the Company could, but does not, furnish the accommodations needed by the public, a report to that effect would undoubtedly have some weight with the Company, and influence on the Legislature during its coming session. If they find that the Company cannot supply additional facilities it would be proper for the Commissioners to recommend such legislation as may be required for the construction of additional lines of road, as was recently suggested by a Board of Rapid Transit Commissioners.

It is, happily, the privilege of any citizens to petition the Board of Railroad Commissioners to make the suggested investigation, and it is undoubtedly their duty to do it after, if not before, their attention is called to the evil. Anyone disposed to call the attention of the Commissioners to the outrageous and insufferable lack of proper accommodation on the elevated railroads can do so by cutting out or copying the following petition, pasting it on a sheet of paper, signing it and addressing it to the Board of Railroad Commissioners, Albany, New York. By inducing others to sign, its weight will, of course, be increased:

NEW YORK..........1887.

To the Board of Railroad Commissioners of the State of New York:

The inadequate accommodation for the transportation of passengers on the Elevated Railroads in this city is now notorious. As the laws of the State of New York make it the duty of your Board to investigate such cases, and suggest improvements and changes required for the reasonable accommodation of the public, you are hereby requested to examine into the manner of conducting the traffic on the roads referred to, and take such further action as you may deem proper to remedy the evil complained of. Respectfully (Signatures).

This would be a direct and practical method, and if such petitions were presented, the Railroad Commissioners would undoubtedly take action on them.

BOOKS RECEIVED.

THE ENGINEERING AND BUILDING RECORD. New York. This is the new title adopted by the journal heretofore known as the *Sanitary Engineer*, the old name being retained as a sub-title. While a change in name of an established paper should always be avoided, if possible, there are in the present case some strong reasons for it. The new name expresses much better the real character and scope of the paper, while the old one was to some extent misleading, as indicating a more contracted field than that really occupied The *Engineering and Building Record* is a paper whose excellence and independence merit continued prosperity, and should secure for it a wide circle of readers.

TRANSACTIONS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS: VOLUME VIII, 1887. New York; published by the Society at the office of the Secretary, No. 280 Broadway.

ANALES DE INGENIERIA: ORGANO DE LA SOCIEDAD COLOMBIANA; published by the Society, Manuel Antonio Rueda, Director; Diodoro Sanchez, Secretary.

NYSTROM'S POCKET-BOOK OF MECHANICS AND ENGINEERING: REVISED AND CORRECTED BY PROFESSOR WILLIAM DENNIS MARKS, PH. B., C. E. Philadelphia; J. B. Lippincott Company (Price, $3.50). This is the nineteenth edition of Nystrom's well-known work, and has been carefully revised and brought up to date, with much original matter. The chief additions in this edition are an elementary article on dynamic electricity and one on the expansion of steam.

THE RELATIVE PROPORTIONS OF THE STEAM ENGINE: BY PROFESSOR WILLIAM DENNIS MARKS, PH. B., C. E.

Philadelphia; J. B. Lippincott Company (Price, $3.00). This is the third edition of Professor Marks' well-known book, and is revised and enlarged, the new matter to the present edition being a chapter on limitations of the expansion of steam, and some new tables. For the use of students the book is interleaved with blank pages on which notes, additions, etc., can be written.

ELEMENTARY TREATISE ON ANALYTICAL MECHANICS: BY PROFESSOR WILLIAM G. PECK, PH. D., LL. D. New York and Chicago; A. S. Barnes & Company (Price, $1.65). This is an addition to Professor Peck's series of mathematical works. It was originally written with a special view to use as a text book in the Columbia College School of Mines, but it will be found a valuable book to many who have passed the school of science but need a book of reference.

A MANUAL OF THE PRINCIPLES AND PRACTICE OF ROAD-MAKING: BY W. M. GILLESPIE, LL. D., C. E.; EDITED BY CADY STALEY, C. E. New York and Chicago; A. S. Barnes & Company (Price, $2.50). This is the tenth edition of Gillespie's standard work.

ELEMENTS OF SURVEYING AND LEVELING: BY CHARLES DAVIES, LL. D.; REVISED BY PROFESSOR J. H. VAN AMRINGE, PH. D. New York and Chicago; A. S. Barnes & Company (Price, $2.00). Davies' Surveying is too well-known as a standard elementary work to require extended mention.

THE HOTCHKISS REVOLVING CANNON: BY LIEUTENANT EDWARD W. VERY, U. S. N. Paris, France; printed for private circulation.

THE HOTCHKISS SYSTEM OF RAPID-FIRING GUNS: DESCRIPTIONS AND ILLUSTRATIONS. London and Paris; printed for private circulation by the Hotchkiss Ordnance Company, Limited.

HANDBOOK OF THE HOTCHKISS TWO-POUNDER MOUNTAIN GUN. Paris, France; issued by the Hotchkiss Ordnance Company, Limited.

OCCASIONAL PAPERS, INSTITUTION OF CIVIL ENGINEERS. London, England; issued by the Institution. The present issue includes several papers of value. The titles are: Leaks in Water Mains, by Messrs. Bryan, Fraser, Restler and Francis; River Tees Improvements, by John Fowler; Flour Mills and their Machinery, by Alfred Chatterton; South African Rivers, by W. B. Tripp; Sinking Pits at Gneisenau, by H. Tomson; Ceylon Government Railways, by F. J. Waring; Removal of Sand at the Liverpool Landing Stage, by W. H. le Mesurier; Experiments on the Strength of Iron and Steel, by John Platt and Robert F. Hayward; Use of Cast-Steel in Locomotive Engines, by Alfred J. Hill; Lumber Industry of Ontario, by M. J. Butler; Abstracts of Papers from Foreign Transactions and Periodicals.

REPORT ON THE RELATION OF RAILROADS TO FOREST SUPPLIES AND FORESTRY: COMPILED BY B. E. FERNOW, CHIEF OF THE FORESTRY DIVISION, DEPARTMENT OF AGRICULTURE. Washington; Government Printing Office.

THE SUTRO TUNNEL COMPANY AND THE SUTRO TUNNEL: BY THEODORE SUTRO. New York; published by the author.

PROCEEDINGS OF THE TWENTIETH ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ARCHITECTS, HELD IN NEW YORK, DECEMBER 1-2, 1886: A. J. BLOOR, EDITOR. New York; issued by the Institute.

DISCHARGE OF WATER OVER WEIRS: BY CHARLES SLAGG. London, England; issued by the Institution of Civil Engineers.

THE YANEGASE-YAMA TUNNEL: BY KINSKE HASEGAWA. London, England; issued by the Institution of Civil Engineers.

NOTES ON RAILROAD CONSTRUCTION IN THE RIVER PLATE, ARGENTINE REPUBLIC: BY THOMAS HOLMES PERRY. London, England; issued by the Institution of Civil Engineers.

OBITUARY.

EX-GOVERNOR ALEXANDER H. HOLLEY, who died at his residence in Lakeville, Conn., October 2, aged 83 years, was for many years largely interested in iron-making in Western Connecticut and Massachusetts. His father, John Milton Holley, was of the firm of Holley & Coffing, who, at Salisbury, cast the first iron cannon made in this country. Mr. Holley accumulated a large fortune and was elected Lieutenant-Governor of Connecticut in 1854 and Governor in 1857. He was largely interested in the building of the Housatonic and the Connecticut Western roads. He was the father of Alexander L. Holley, the distinguished engineer who died several years ago.

J. W. SHERWIN, who died in Erie, Pa., September 24, was a civil engineer well-known in the West. He was 50 years old; when still a young man, he made the preliminary survey for the old North Missouri Railroad. Subsequently he surveyed the Belleville Branch of the St. Louis, Alton & Terre Haute, and made the first borings and explorations for a bridge over the Mississippi at St. Louis. He was for some time Assistant Superintendent of the Chicago & Alton. He afterwards went to Iowa and was prominent among the settlers of the western part of that State.

FREDERIC W. VAUGHAN, President of the Louisville Bridge and Iron Company, died recently at Louisville, Ky. Mr. Vaughan was born at Warren, Me., June 6, 1844, graduated at the Rensselaer Polytechnic Institute in the Class of 1863, and was elected a member of the American Society of Civil Engineers in 1869. He went to Nashville during the war as Assistant Engineer on Government railways and has since been prominently identified with much of the bridge construction of the South. He served as Principal Assistant to Mr. Albert Fink on the first bridge across the Ohio at Louisville, and has been closely connected with the Louisville Bridge & Iron Company ever since. In addition to the presidency of this company he held at the time of his death the positions of Chief Engineer of the Henderson Bridge Company and Consulting Engineer of the Louisville & Nashville Railroad.

HON. L. A. SENECAL, who died in Montreal, October 11, was for many years one of the most prominent railroad men in Canada. As a financier and politician he rose to the highest rank. He had been the President of the Richelieu & Ontario Navigation Company for years, and had made of that line one of the most extensive fresh-water routes in the world. He was General Superintendent of Government railways, and President of the North Shore Railway Company and of the Montreal City Passenger Railway Company. In 1857 he opened the Yamaska River to navigation from Sorel to St. Aime, and the St. Francis River from St. Francis. Among the railroads which he constructed are the following: Richelieu, Drummond & Arthabaska; Laurentian Railway; St. Eustache Railway; Berthier Railway; Lanoraie, Joliette & Valois; L'Assomption Railway, and the Basse Laurentides Railway. He built and worked the railroad over the ice on the St. Lawrence from Montreal to Longueuil.

Under his management the Richelieu line was extended from Hamilton and Toronto to Chicoutimi, a distance of nearly 1,000 miles. He was an active politician, and for several years was said to control the provincial Legislature of Quebec.

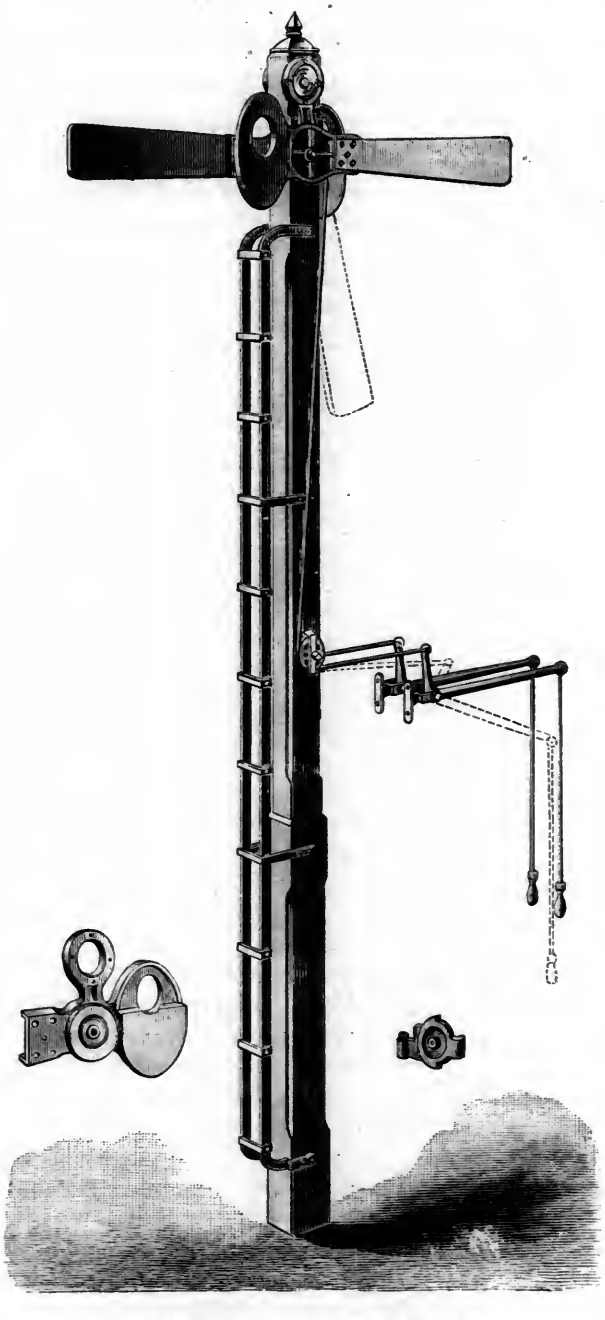
Harrington's Semaphore.

THE engraving represents an improved semaphore signal, designed by Mr. S. H. Harrington, Mechanical Engineer of the Pittsburgh, Cincinnati & St. Louis Railroad, and which is made by the Barney & Smith Manufacturing Company, of Dayton, Ohio.

Without any strikingly novel features, the semaphore is so designed as to cheapen its cost, and reduce it to a practical form. The signal lamp is placed on top of the post, as shown. The semaphore blades are attached to a casting, shown separately on the left side of the engraving. This casting has two openings; one of them shown on top has a red lense. and the other is open. When the blade is in the position represented at the top of the engraving, the red lense comes in front of the lamp; when the blade is down, as shown by the dotted lines, the other opening comes in front of the lamp, which then shows a white light. The same pattern of casting can be used for each of the semaphore blades, and the same lamp answers for both.

The casting has a sheave on it, shown in the left side of the engraving, around which a wire rope is wound which raises the signal. The levers with which it is operated are shown in the engraving. These can, of course, be located in any convenient position.

This signal is now in use on the Pan-Handle, the Cincinnati, Hamilton & Dayton, the Bee Line, the Louisville & Nashville, the New York, Lake Erie & Western, the Fort Wayne and other roads, and it has the merit of being simple, practical and cheap.



HARRINGTON'S SEMAPHORE.

Contributions.

THE PRINCIPLES OF RAILROAD LOCATION.

By Professor C. D. Jameson.

INTRODUCTION.

The object of this book is not alone to furnish additional data and information to our educated engineers, men who have the higher mathematics at their fingers' ends and the leisure to use them, who, if they can learn nothing else from what follows, can at least learn something, we hope, of simplicity and clearness of explanation. This book is written also for that great body of readers who have never had a chance to acquire any knowledge of higher mathematics, or, if they once had this knowledge, have long since forgotten it from lack of time or necessity of making any practical use of it.

It is hoped that the following explanations will be made so plain and simple that any one with common sense and a common-school education who takes any interest in railroads, either as owner or employé, may be able to fully understand not only the general principles upon which a Railroad Location is based, but also the methods used both in the field and office in actually carrying on the work.

It will be found impossible in some cases to do away entirely with mathematics, but wherever they are used, much care will be taken to introduce them only in their most simple and elementary form, so as to enable the reader, with very slight study, to understand their application at once. Undoubtedly many of the explanations will be much longer than if more mathematics were used, but this lack of conciseness will, we think, be more than counterbalanced by the fact that the general reader, student and ordinary engineer will be able at once to understand what we are explaining and will thus be led to read and study the following pages, while they would turn away without making an effort, were the explanations covered with a mathematical coating which, however much it might shorten them, would, to a great extent, conceal them. Therefore let the educated and advanced engineer excuse what appears to him a uselessly long and roundabout explanation, and let him remember that hundreds of our best engineers in Railroading never had the time or opportunity for advanced study in mathematics, and that there is a large number of engineering students to whom this book may prove useful; while more in number than all these is that multitude of people who are interested in whatever pertains to railroads, and who may like to understand the general principles upon which the location of a railroad is based as well as the methods employed in the field and office in doing the work. It is, therefore, for these last two classes that this book is written, and it is the hope of the author that they will find all the questions so clearly explained that, with very little study, they may be able to understand fully all the problems presented, and thus acquire a full knowledge of the fundamental principles of Railroad Location.

One word more before we finish this Introduction:

LOCATING ENGINEERS ARE BORN, NOT MADE.

Some eminent authors on this subject have denied this fact, claiming that, with but ordinary powers of observation, anyone by proper attention to set rules could make a good locating engineer. No one can make a good locator of himself any more than he can make an artist or musician. It must be born in him. Then, if he has this gift or talent, hard study and constant practice will bring him each day nearer and nearer perfection. But without this natural talent, or, as it is sometimes technically called, "eye for country," he may study and memorize all that is written on the subject in the shape of rules or explanations and may practice in the field continually; let him be put into a new country under slightly varying circumstances, and ninety-nine times out of a hundred he will not only waste much time and money upon useless surveys, but in the end will have far from the best line between the given points. Men of this kind usually make the best of assistants. They are hard and faithful workers and obey orders to the letter. They can conduct surveys in the best manner where they act under orders, but they should never be found on reconnoissance, and it would be economy for all railway companies if care were taken that these men never conducted location—economy in the location, construction and, more than all, in operation.

As location is an art and not an acquired quality, it follows that each locating engineer has his own individual methods of carrying on the details of the work and solving the many problems that arise. This more particularly applies to the reconnoissance than to any other part of the process of railroad location, as in that is shown, more strongly than anywhere else, the personality of each individual. What we propose, therefore, is not to give fixed rules to be applied in all cases, but to place before the reader the results which are required and the fndamental principles upon which the obtaining of these results are based, together with the methods used in the field and office of conducting the work after the reconnoissance has been made, and a full descripton of all the instruments used.

CHAPTER I.

QUESTIONS TO BE ANSWERED BEFORE THE LOCATION BEGINS.

There are many questions which must be carefully studied in regard to a proposed railroad before any of the work of location begins, and the first is whether it will pay to build a railroad at all. In this country, railroads have been built with one of the following objects in view.

First, when built without any regard as to whether they will pay as a business enterprise, as when a road is built by the State for the supposed good of the people of the State.

Second, when a railroad is built parallel to another railroad or running through the same section of country, knowing that there is not enough traffic for both. The only object in this case is to blackmail the already existing railroad.

Third, when built simply to make money out of the construction. That is, when certain men form a railroad company, raise the money to build the road and then let the contracts to themselves at any price for the work they may choose to fix.

Fourth, when built purely as a legitimate business transaction, for the purpose of making money in a legitimate manner by operating the road. It is with this fourth class only that we have to do, where the idea is to make

every dollar do as much work as possible, but also to have all the work done in a first-class manner and to have no false economy. To decide whether the railroad will pay or not, a most careful study must be made of the resources of the country through which it is going to run, both as to the present and future. The terminal points of the railroad, that is, where it shall start from and where it shall run to, are a question, which, as well as No. 1, is seldom left to the engineer but is decided on a broader basis by the Executive Board of the Railroad Company, and thus, under most circumstances, the engineer is relieved of the responsibility of deciding the two most important questions to the future railroad.

Having decided to build a railroad, and also where to build it, as far as the terminal points are concerned, we come next to the question as to what gauge is to be used, whether standard (4 ft. 8½ in.) or narrow (anything less than standard). There are many points which can be urged in favor of both standard and narrow gauge, and indeed some years ago many miles of narrow gauge road were built; but a large part of these lines has since then been changed to standard, because, notwithstanding all that can be said in favor of the narrow gauge, all the advantages that can be claimed are more than counterbalanced by the fact that the standard gauge is the standard; that is, that the majority of the railroads in this country are of that gauge, and this one point of uniformity, is under all ordinary circumstances of very much more importance than any mere difference in the distance between the rails. The gauge of a railroad is the distance between the rails, and should be measured between the inside of the tops of the rails.

Another question is whether the railroad shall be built in a substantial manner in the beginning, or whether it shall be built in a temporary manner, just good enough to allow it to be opened to the public and transact business and afterward be improved and put in first-class condition from its earnings. This, to a great extent, depends upon the ability of the railroad company to raise money. Of course, the first cost of construction is much more when the road is built and finished in a thorough manner in every respect, but the cost of operating the road is much less, and it must be remembered that this cost of operating is an expense that goes on day by day, increasing with the traffic (but not in the same ratio), while the cost of construction is spent once for all, and the only thing to be considered is the interest which has to be paid for the extra amount of money used in construction; and the extra amount that can be spent on construction is the principal, the interest on which would equal the increase in the operating expenses, if this additional amount were not spent on construction. This would be the case if the railroad company could obtain all the money it needed. But, as this very seldom happens, many of our railroads which are to-day substantial lines in every respect, and paying roads also, could never have been built at all, if it had been required to make them first-class in the beginning.

There is one thing, however, that should never be allowed under any circumstances, and that is that this spirit of economy should be carried so far as to in any way endanger human life, as by the use of cheap, weak bridges or inferior and old-fashioned appliances such as hand brakes, stub switches, etc.

No amount of money saved in the location or construction can compensate for one human life lost, and as the railroad companies take and hold what property they need by the "Right of Eminent Domain," for the benefit of the Public, the law should see that no work is permitted which in any way endangers human life, and compel all railroad companies to use the most approved safety appliances. This is meant to apply to those roads doing business in such a way that, by the absence of the most approved appliances, human life is endangered. On a small road, running only a few trains, and those trains at a slow rate of speed, there is really little risk to the passengers or employés with the most rude appliances in the shape of brakes, switches, etc. All the superstructure may also be much lighter on these small roads, but the material of which they are built should be first-class, otherwise it would be impossible to judge in any way of its strength.

Having decided upon the terminal points, the next thing is to carefully study the resources of the country between them in order to form as exact an idea as possible of the amount of future traffic that will probably be done by the road. To do this there must be taken into consideration all the intermediate towns of whatever size, and without regard to whether they are on the probable line of the railroad. All resources, such as water power, mines, etc., that at the time are valueless, owing to the lack of transportation, must be studied with care.

All the business of the future road may be divided into two kinds, "Through Traffic" and "Way Traffic."

The "Through Traffic" is (1) that which goes directly from one terminus to the other; or (2) is carried over parts of two different railroads either from or to the terminal or intermediate stations.

The amount of Through Traffic a railroad may have depends, to a very great extent, upon the terminal stations and the connections it makes there with other routes of transportation.

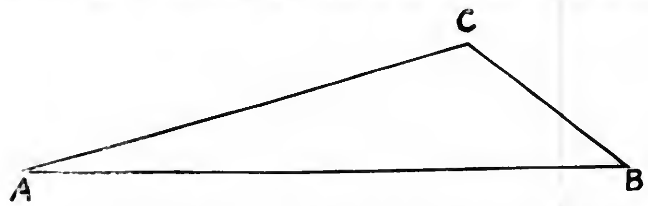
The Way Traffic is that traffic which goes from the terminal stations to the intermediate stations on the same line, or the reverse, and also that between the way stations. The amount of this Way Traffic depends not only upon the resources of the country through which the railroad runs, but also upon the connections made at the terminal stations. Unless the country has resources within itself, which are or can be developed, there will be very little Way Traffic to start with, none going from the intermediate stations outward, and, consequently, very little, comparatively, coming in. The same will be the case, even if we suppose that the intermediate stations are rich in resources, if there are no connections at the terminal stations to carry the products to a market.

The probable traffic of the road is the first question to be studied. This is the business for which the road is built and upon a correct, or at least approximately correct answer to this depends the future success of the proposed railroad. This is very much more the case in America and Mexico than in England and the more populous parts of Europe. In England and Europe, the whole country, so to speak, was under cultivation before the age of railroads, and their introduction simply enlarged the market for already existing products. With us it is exactly the opposite. Three-quarters of our railroads were pushed out into a wilderness far ahead of civilization and cultivation, and the business of these roads was created by them and after they were built. In England and Europe, the

railroads were built because the traffic existed and they were needed. With us the roads were built, and then, from the fact that they were built and offered facilities for transportation, the business which to-day makes them able to pay interest on the cost of construction was made possible and became a fact. It is. of course, evident that, although in England and Europe the traffic existed largely before the introduction of railroads, still, even in those countries, the introduction of railroads has increased that traffic by a hundred fold. The next question to study is the class of the future traffic. That is, of what will the bulk of the business to be done by the road consist. Will it be passengers or freight or both, will the freight be all of one kind, such as coal, mineral or grain, or will it be of a general, mixed character? These questions affect the location, cost of construction and cost of operation. A road that does only one kind of freight business can be built and operated much more cheaply than one that does a mixed businesss. The terminal facilities are much fewer and much simpler, and therefore can approach nearer perfection; only one kind of rolling stock is needed and one class of locomotives. The trains, being all of the same class, run at about the same speed; therefore the track can be put up in just the shape to suit this speed and rolling stock, and thus the expenses of manitenance of way much reduced. The drawback to this kind of business is that it is usually all or nearly all in one direction. We must next consider the question as to the direction in which the bulk of the traffic will have to be carried. Will it all be carried in one direction, or will it be more equally divided, some going in each direction so that the cars can be loaded both ways. If there is only traffic in one direction, the trains going in the opposite direction will only have empty cars to haul, and this return trip will be a loss either to the railroad company or to the shippers. This question is also one which affects very seriously the location of the line and the establishment of the grades; because, if the amount of traffic is the same in both directions, the grades which oppose this traffic must be as nearly the same as possible for the most economical working of the road; while, if the bulk of the traffic is in only one direction so that the returning trains are run light, much steeper grades can be used to oppose these light trains than those which oppose the more heavily loaded ones, and thus much money can often be saved in the cost of construction by so adjusting the grades on the location that their relative resistance to the movement of trains is inversely as the relative amount of the traffic each way. The next question is that of intermediate stations. We have decided upon the terminal stations, and between them are a number of small towns of greater or less importance, which all, to a certain degree, wish the railroad to come to them, and which, to a certain extent, it will pay the railroad to reach. None of them are on the shortest or best line for a railroad between the terminal stations, and it will increase the first cost of construction to build the road to them, besides making it necessary to haul all the through business a longer distance for the same amount of money. (We say a longer distance for the same amount of money, because the rates of through freight to-day are based, in most cases, not upon the actual distance hauled but upon outside circumstances that, within certain limits, have nothing whatsoever to do with the distance hauled.) The question to be decided is, then, whether the extra business to be procured by thus increasing the actual length of the line will pay the interest on the increased cost of construction due to the increase of length and also the cost to the railroad company of hauling all the other business this extra distance. If the profits from this extra business will pay this additional expense, then build the road to these intermediate towns, but if the profits from this extra business are not enough to pay the additional expense, and there is no reason to believe that there will be sufficient business at any future time, then the road should not be carried to the intermediate towns.

It should be remembered that mere increase of distance by a comparatively small amount, is in itself a very small thing, and that it takes, generally speaking, a very small amount of extra business to pay for the extra length. In the first place, the cost of running an extra mile is a very small proportion of the cost of running the whole distance. Then, under some circumstances, this extra length may be a positive gain, as in the case of passenger traffic, where the rate is so much a mile. If it is a profitable business to carry the passenger 90 miles at a given rate per mile it is more profitable to carry him 100 miles. Often in the case of through lines where the given road forms a link, the longer the link the greater proportion of the whole chain it is, and the greater proportion of fare it will receive. In this question of intermediate towns, we must clearly understand how much the traffic of the road is increased by the addition of one extra station.

We will suppose that we have a railroad running from *A* to *B*, and the traffic of *A* and *B* is the same. Between



A and *B*, is the town *C*, which is a little off to one side; now, if the line runs from *A* to *C*, and from *C* to *B*, and the amount of traffic due to *C* is the same as to *A* and *B*, then the amount of the whole traffic of the road is multiplied by two, and in most actual cases by three, and, as the number of stations is increased, it is a safe rule to say that the traffic of the road will increase by the number of stations, minus one, multiplied by three. This, of course, supposes that each station shall have an equal amount of traffic. According to the above rule, if we increase the number of stations to six, we multiply the traffic by 15. This rule would apply exactly only in ideal cases, but the engineer, and particularly the young engineer, should have all these possible facts firmly fixed in his mind: That a line of railroad can swerve to one side or the other of a right line a good many degrees without materially increasing the distance; that it takes comparatively a very small amount of extra traffic to pay for this extra length; that in many cases this extra length is a direct gain to the railroad. It may be, however, that sometimes, where this extra length is a gain to the railroad, it is a loss to the shipper and consequently is bad policy. Unless there are urgent reasons for increasing the length of a railroad line, such as intermediate stations or topographical obstacles, the length should never be increased simply that a larger amount may be charged for transportation. In these days of competition and multiplicity

of railroads, this would be a most dangerous policy for a company, for the reason that where a line of railroad between two points is longer than there is any necessity for (if those terminal points are of any importance from a business standpoint), it is very certain that a shorter and better line will be built which, for the same rates, can do the business at a greater profit.

In considering the question of branch lines, always remember that, in themselves, branches are very seldom profitable. Unless there are very imperative reasons, why the main line should not be carried through the towns, branches should never be built. But when and where they are built, the only way they pay is in connection with the main line. There are cases where a branch pays in itself, but it is only when it is in such a location and under such condititions that it amounts to a main line. In thus speaking of branch lines, we mean those which are built for ordinary business and not branches which are built for special purposes, such as those running to coal mines, lumber or flour mills, where the business is all of one class, and the probable amount of it can be very exactly estimated. If such special branches do not pay in themselves, it is simply from lack of judgment in the estimates made as to the future traffic.

Another question to be studied before the location is made is the probable cost of the right of way. The importance of this question varies as to the locality in which the railroad is to be. In a wild, unsettled country, the land necessary can usually be had for nothing, while in thickly settled countries where land is valuable, the land for right of way becomes one of the greatest items of expense. This is plainly seen in the great difference there has been in cost of the right of way in England and in this country.

In England the average paid for land, including that used for shops, stations, etc., is £4 000, or nearly $20,000 per mile, while with us the average per mile has been less than $1,000. When possible it is a good plan to let it be understood that the building of the railroad to certain places depends greatly upon the price which will have to be paid for the right of way; not that the railroad company wishes to get the land for any less than a fair price, but simply that it wishes to get it for a fair price and will not be subjected to extortion.

It is strange how the business honor and rectitude of men disappears when dealing with railroads in general, and particularly in the regard to the right of way.

Men who would be shocked at any intimation that they would lie, will deliberately swear that their land is worth ten times as much as they ever thought it was, if a railroad company wishes to buy it. Even when the company will not submit to this extreme extortion and pay the owner the price he asks for the land, and demands a commission to settle the price that shall be paid, it is but a sorry remedy. The commission is appointed from among the friends and neighbors of the land-owner, who are all prejudiced against the railroad and consider it so much in their favor if they can make the company pay well. The company has to pay all the expenses of the commission and then be cheated by it.

Why this purchase of the necessary land by a railroad company should have to be conducted in a manner so contrary to general business principles one cannot understand. A railroad company should be obliged to pay a man a most exorbitant price for improving his property ten-fold, for no one can now deny that, upon general principles, all property is improved by a railroad. There are, of course, exceptions to this rule, but these exceptions usually get exceptional payment.

The state of the money market must be considered before the work of location begins. This question does not now refer so much to the power of the company to raise money, due to its financial standing, as to whether money is scarce or not; whether capitalists, great or small, are seeking investments for their money. There are times when everything is on a "boom," and when money can be had for any scheme for almost the mere asking, and other times when, no matter how solid the scheme is, money can only be procured by paying a very high rate of interest.

The money used in building a railroad has generally been raised in two ways:

1. By issuing bonds and selling them in the public market.

2. By issuing and selling stock. (This method has been for some past falling into disuse.)

The bonds are simply a mortgage for a specified amount upon the property of the railroad company. This mortgage runs for a specified length of time and has a specified annual interest. When this interest becomes due and is not paid, the mortgage can be foreclosed the same as any other mortgage. When the specified term of the mortgage expires, the principal must be paid.

In order to protect the small bondholders, railroad mortgages can usually be foreclosed by the vote of a portion of the holders.

The stock differs from the bonds in the fact that there is no stated amount of interest to be paid on it, but that whatever moneys from the receipts of the road remain over and above the expenses and interest on the bonds shall be divided proportionally among the stockholders in the shape of dividends. The stock also differs from the bonds in not constituting any lien on the property of the railroad company, and if the company goes into bankruptcy, the stock becomes worthless, and the holders of it lose whatever they have paid for it. The stockholders are simply in the position of the man who owns the equity of redemption on a mortgaged farm.

Now, if there is very little money seeking investment, and the future prospects of the road are in any way doubtful, either on account of the lack of resources in the country through which it runs, or on account of the men at the head of the enterprise, the bonds and stocks must be sold at a great discount, and the liabilities of the company made very large in proportion to the amount of actual money it has at its disposal.

This question should therefore be studied with much care, in order that, after the work has once been commenced, it will not have to be stopped on account of lack of funds, and also that when it is finished the debt may not be so large that the road will never be able to pay a fair rate of interest.

Of late years the practice has grown up of building roads entirely from the sale of bonds, the stock being either given as a bonus with the bonds, or, more often, kept by the projectors for their own benefit. In the latter case the control and management of the road remain with parties who have contributed little or no money, while the real owners have no voice; a condition of affairs

which is not desirable, and which has led to many abuses.

The state of the material market is usually of less importance to the railroad company than the state of the money market, for in these days of cheap and rapid transportation, the markets of the whole world compete at every point, and, under all ordinary circumstances, material can always be purchased at a fair price. Still, the question should be studied with care, not only as to what the material will cost at the factory, but also as to what it will cost at the point where it is to be used. In new and uncivilized countries this last is often the most important question.

In Mexico, for example, at the time of the building of the railroad from Vera Cruz to the City of Mexico, it cost $75 per ton to haul the rails from Vera Cruz to the City of Mexico over the mountains, on account of a clause in the concession which required the track-laying to be carried on from both ends at the same time.

In building the Mexican Central the freight on the rails was $24 to $22, delivered in Vera Cruz, from either New-York or Liverpool, and then between $40 and $50 per ton over the Vera Cruz line to the City of Mexico.

The word material, as it is used here, includes not only what is commonly called material, and used in the construction of a railroad, such as rails, ties, bridges, etc., but also all manual labor and superintendency required to do the work and put the material in place. It therefore includes the question of wages and consequently of the supply of labor.

We have thus called attention to the principal points which should be studied and answered with as much exactness as possible, before any of the work on location begins. The manner of solving these questions may differ in each case, and special questions may come up which will require special methods to solve.

However this may be, let the student, engineer or business-man get firmly and clearly fixed in his mind the different points which he must study and the relative bearing and importance of these points, and then, by the use of his own commonsense and his own or some other person's experience, he cannot fail by hard study to arrive at a satisfactory result.

NOTE.—The reader is referred to the following books as the best authorities on the various subjects to be treated of in these articles:

"Manual for Railway Engineers," by George L. Vose.
"The Economic Theory of Location," by A. M. Wellington.
"Railway Curves," by John C. Trautwine.
"Field Engineering," by William H. Searles.
"Topographical Surveying," by J. B. Johnson,
"Elements of Railroading," by Charles Paine.

The author has carefully studied these books and has endeavored to give each credit for anything he has taken directly from it, but in instances when this has been neglected, he begs now to acknowledge his indebtedness to their authors, one and all.

The author also wishes to return thanks to Professor George L. Vose; A. A. Robinson, Second Vice-President, Atchison, Topeka & Santa Fé, and Professor A. E. Burton, of the Massachusetts Institute of Technology, for the kind assistance they have rendered him in collecting some necessary data.

(TO BE CONTINUED.)

HOW ELECTRICITY IS MADE.

BY LIEUTENANT BRADLEY A. FISKE, U. S. N.

FROM the words printed above, it might be inferred that the generation of electricity is a difficult matter and one requiring special apparatus and instruction, but, as a matter of fact, it is much more difficult not to produce electricity than to produce it; and, in refined experiments, the persistent tendency of electricity to obtrude itself where it is not wanted necessitates special means to keep it away and is a distinct source of annoyance to the experimenter. If any two metals, or any two pieces of the same metal, are joined by a wire, or if they are in contact with each other, electricity will be present; and, if both are immersed in water, a current will pass from one to the other; and everybody knows of the trouble caused in mills by the electricity produced by the friction of the belts in passing over the pulleys. The amount produced by these means is small, of course, and is not under good control; yet the generation of electricity in large quantities and in a controllable form has followed, as will be seen, from observation of and experiment with as simple phenomena as these.

For six centuries before Christ it was a matter of general knowledge that amber and jet, if rubbed, would attract light bodies; and the science of electricity remained limited to this knowledge until 1600 A. D., when Dr. Gilbert discovered that the same curious property was possessed by many other bodies besides. It was not, however, until the discoveries of Galvani and Volta, nearly two centuries later and only one century ago, that electrical phenomena began to be regarded as pointing to any practical results; but, when these learned physicists announced the results of their experiments on the nerves and muscles of frogs with different metals in contact, the scientific men awoke to the fact that a wonderful force had been evoked; and since that time, the discoveries and inventions made in electricity have surpassed those made in any other branch of science.

It will be remembered that about 1786 Galvani observed that if two dissimilar metals were brought into contact, respectively, with the nerve and the muscle of a frog's leg and then into contact with each other, a quick convulsive movement of the frog's leg would follow, and that Volta proved afterwards that the electricity thus evidenced was produced not by the frog's leg, but by the contact of the dissimilar metals. In substantiating the truth of his position, he constructed what is now called "Volta's Pile," consisting of discs of zinc and copper in contact with each other and separated by a disc of moist cloth or paper from a similar pair of metals, which were similarly separated in turn from a succeeding pair. The whole pile comprised a large number of such pairs, zinc being at one end of the pile and copper at the other, and when the ends of the pile were connected by a wire, a considerable current was shown to flow from one to the other. Volta also constructed a cell consisting of a strip of zinc and a strip of copper in dilute sulphuric acid, and this cell, in various modified forms, is in use all over the world to-day.

The necessity for any modifications of this cell—known as the simple Voltaic cell—lies in the fact that a very little use will cause it to run down, or to "polarize," as it is usually called. The passage through the cell of the elec-

trical current which it produces causes a chemical action therein, hydrogen being evolved and going to the copper plate, where it forms in a thin film, which not only resists the passage of electricity but also prevents the action of copper as copper, and in most of the numberless batteries invented, the primary object is to destroy the hydrogen as fast as it is evolved.

In the Le Clanché battery, shown in fig. 1, the copper is replaced by a rod of carbon which is surrounded by powdered binoxide of manganese, a substance rich in oxygen. The two are enclosed in a porous jar which, with the zinc rod, stands in a solution of sal-ammoniac. The oxygen in the binoxide attacks the hydrogen, and, if electricity is not generated too fast, it destroys the hydrogen as fast as it is evolved. If, however, electricity—and therefore hydrogen—is generated beyond a certain rate, the battery will run down, or polarize, and will remain in that condition until it has been allowed to rest long enough to give the oxygen time to destroy the accumulation of hydrogen. This fact of requiring frequent rest explains why we use the Le Clanché battery, though cheap, simple and clear, only in such work as ringing bells and operating telephones, where the work is intermittent—not continuous.

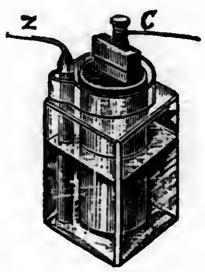


Fig. 1.

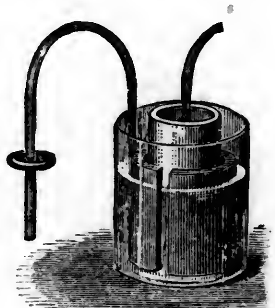


Fig. 2.

For continuous work, such as telegraphing, a battery is evidently required which will not polarize, no matter how long it is used, and for this purpose the Daniell battery—or some modification of it—is employed all over the world. In this cell, shown in fig. 2, a plate of zinc stands in dilute sulphuric acid, in which stands also a porous pot holding a plate of copper in a saturated solution of sulphate of copper, there being also a sort of shallow cup on the rod of the copper plate which holds a few crystals of sulphate of copper, intended to maintain the saturation of the solution. Now, the hydrogen, in passing towards the copper plate, meets the surrounding solution of sulphate of copper, which immediately takes it up, giving up an equivalent amount of copper and depositing it, instead of the hydrogen, at the copper plate—so that hydrogen is destroyed as fast as generated, and polarization is completely prevented. Possibly the cell shown in fig. 3 may be more familiar to most readers than that in fig. 2, but it is merely a modification. It is called the gravity cell, from the fact that the two solutions are kept apart by gravity instead of by a porous pot, the sulphate of zinc, from its smaller density, floating on the sulphate of copper. There are countless forms of voltaic cells, but the Le Clanché and the Daniell are those ordinarily used. Other cells are the Bunsen cell, in which the zinc stands in dilute sulphuric acid while a rod of carbon stands in nitric acid; the Grove, in which a bar of platinum instead of carbon stands in the nitric acid, and the Grenet battery, much used in medical apparatus and shown in fig. 4, in which two plates of carbon stand in a solution of bichromate of potash, there being no action until a plate of zinc is lowered between them by means of the rod shown. This cell gives very strong currents for a short time; but, like the Le Clanché, requires frequent rest; and it requires, in addition, that the zinc be lifted out of the solution during rest.

Fig. 3.

During the early part of this century, many and very costly experiments were made, looking to the employment of electricity on a large scale for running electric lights and working electro-motors; but though the experiments were successful from a scientific view, they failed to bear fruit in a practical way, for the simple reason that the chemicals used, principally the zinc, were so expensive and were consumed so fast, that the cost was altogether out of proportion to the results obtained; and were it not for the discovery of Faraday in 1831, the world might still be without the practical benefits attending the use of the

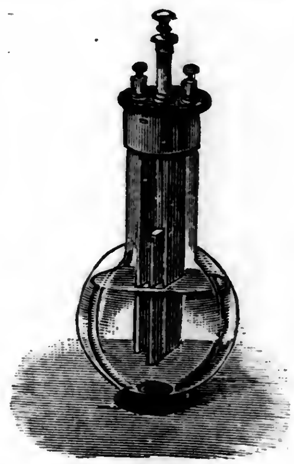


Fig. 4.

electric light and the electric motor on an extensive scale. In coming to Faraday's discovery, it may be well to recall the fact, well known to everybody, that a piece of iron becomes a magnet (called an electro-magnet) while a current of electricity traverses a wire wrapped around it, and that it ceases to be a magnet when the current ceases;

but perhaps it is not so generally known that a simple helix or coil of wire, when traversed by a current, also becomes a magnet, with a north pole at one end and a south pole at the other end, even though there be no iron core, and that even a single loop of wire, such as is shown in

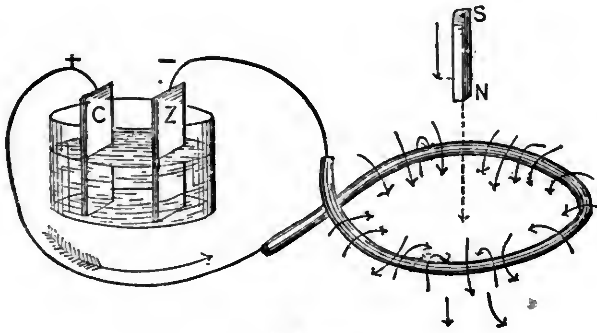


Fig. 5.

fig. 5, becomes under similar circumstances a veritable magnet, and will attract or repel a magnet pole in the vicinity according as the current is in such a direction as to make the adjacent side of the coil a north or a south pole. Now, Faraday made the happy discovery that the converse of this is true; in other words, he found out that if a magnet pole and a closed coil of wire were made to approach each other, a current would immediately traverse the wire, even though there were no battery connected to the wire; and that a current would traverse the wire in the opposite direction if the magnet and the coil were separated. He discovered that, if he used the other pole of the magnet, the directions of these two currents would be interchanged, the approach of the north pole and the coil producing a current in the same direction as the separation of the south pole and the coil and *vice versa*. He discovered that the strength of the current was proportional to the strength of the magnet pole, and that it was proportional also to the rapidity of the motion, a strong current following a rapid motion and a weak current following a slow motion. He discovered that the mere presence of a magnet pole produced no effect, the current lasting while the motion lasted but ceasing as soon as the motion ceased. Further thought and experiment developed the important fact that in all cases of approach or separation of coils and magnet poles, the current induced was in such a direction as to form a pole in the coil which *opposed* the motion of the magnet pole producing it, so that in order to maintain relative motion between the coil and the magnet pole, a considerable force was required to overcome the attraction in the case of separation and the repulsion in case of approach; and since the current induced was greater after a rapid motion than after a slow motion, there was greater resistance to making a rapid motion than to making a slow motion.

Now, this resistance we know at the present day is just what might have been expected, for we know that the production of an electrical current is the production of energy in a certain form and can be obtained only by the expenditure of an equal amount of energy in some other form; so that the energy which Faraday expended in moving the magnet poles against the resistance opposed was simply converted into the electrical energy of the current he evoked.

The announcement of his discovery by Faraday attracted at once the attention not only of pure scientists but of inventors, for its practical value was evident at a glance. It was clear at once that if electricity could be generated by simply moving magnets and coils near each other all the commercial difficulties attending the employment of electricity for lights and motors would vanish, because steam engines as large as necessary could be made to move coils near large magnets; and since the cost of the electricity would depend principally upon the cost of the coal for running the engine, it could be cheaply produced, for the reason that coal was many times cheaper than zinc, and contained, besides, about six times as much heat, which they knew meant six times as much power to do work.

During the next few years, great was the activity among inventors and electricians, all striving to produce a practical machine for generating electricity in large quantities; but it cannot be said that very valuable results were obtained until the advent, in 1870, of the Gramme machine, which closely resembled a machine previously invented by Pacinnoti, but which, for some reason, had not attracted much attention.

In order to get a clear comprehension of this machine—and in fact of all electric machines—it is absolutely essential to consider a principle laid down by Faraday which may seem difficult at first, but which, once understood, the action of all electric machines becomes immediately apparent.

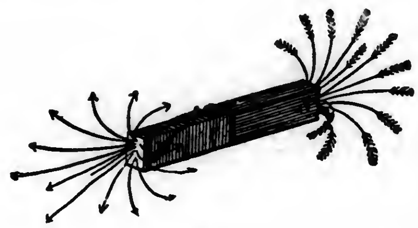


Fig. 5*a*.

Before reciting this principle, it may be well to call to mind the fact that the poles of a magnet reach out into the surrounding air and tend to attract or repel neighboring magnet poles and also induce opposite poles in pieces of soft iron at hand, so that if a piece of soft iron lie near a north magnet pole a south pole will be induced in the side near the magnet pole, and attraction will ensue. The surrounding air may then be conceived to be full of "lines of force" which run, let us say, in the direction in which a north pole, there placed, would tend to move, that is, away from the north pole of the magnet and toward the south pole; and fig. 5 *a* shows a bar magnet with lines of force running from the north pole and into the south pole.

That these lines of force are not purely imaginary, may be easily shown by the simple expedient of sifting fine iron filings upon a piece of card board and placing the poles *N* and *S* beneath, as indicated in fig. 6, when the iron filings will range themselves in lines as shown, radiating from the poles. But it is not only magnet poles which have this capability, for it can be shown by a similar experiment that any wire when traversed by an electric current throws out lines of force and possesses magnetic power, for if held near a magnet pole, it will deflect it to the right or the left, and if passed through a hole in a card-board over which fine iron filings have been sifted, the filings will

arrange themselves in circles, showing that a wire traversed by a current is surrounded by magnetic lines of force which circle about it. If now such a wire be bent into a loop, as in fig. 5, it will be seen that the lines of force combine to run out of one side and into the other, forming a north pole and a south pole, respectively.

Now, such a coil is said to "embrace" these lines of force, and the number of lines of force is proportional to the strength of current; or, which is the same thing, is proportional to the strength of its poles, a strong current and strong poles carrying a greater number of lines of force than a weak current and weak poles.

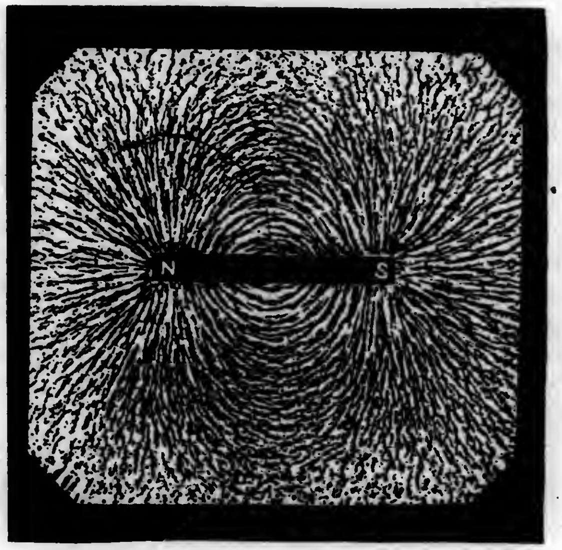


Fig. 6.

But a coil can embrace other lines of force besides those due to its own current; it may embrace also those due to a neighboring magnet pole, the lines of force coming direct from a north pole being usually considered as being positive in direction—or, as sometimes expressed, being positive lines of force, and those from a south pole being negative. In fig. 5, the coil is shown as embracing the lines of force due both to its own current and to the adjacent magnet pole.

We now come logically to a statement of Faraday's principle, which is that *when a conductor is so moved in a magnetic field as to cut the lines of force, a current is set up in the conductor at right angles to the motion.*

But it can be shown that if the wire be bent into a loop, it is possible to so move it that no current will be set up, because the current generated in one side of the coil can be made to oppose that generated in the other side. It is, therefore, necessary to so move the coil that the current generated in one side of the coil will be greater than that generated in the opposite side, and this we see that we can do quite easily by the simple expedient of rotating the coil as shown in fig. 7, for in this case the top of the coil evidently cuts more lines of force in a revolution than the lower part, so that the current generated in the upper part overpowers the weaker opposing current generated in the lower part. A better way to consider this case, however, is to regard the coil as *embracing* a certain number of the lines of force, when it immediately becomes clear that a current is generated in a coil when the number of lines of force which it embraces is *changed*, a current in one direction following a decrease in the number of lines of force embraced, and a current in the opposite direction following an increase. If, also,

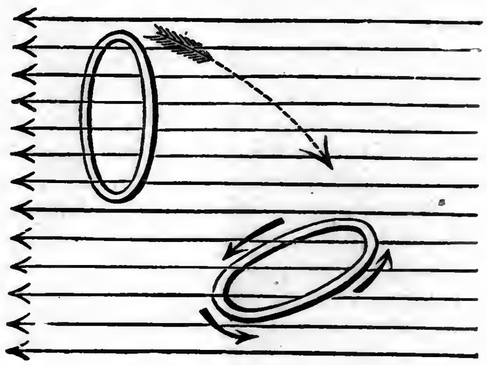


Fig. 7.

a coil be moved as indicated in fig. 8, a current will set up, since, though the coil is not rotated on its axis, it is moved from a field in which positive lines of force enter one side to a field in which negative lines of force enter the same side; and, though the absolute number of lines

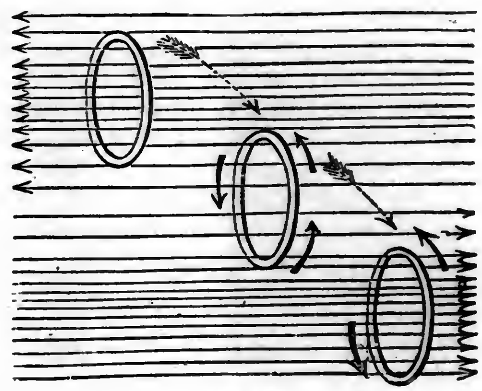


Fig. 8.

may be the same in both cases, a change from positive to negative lines is, in reality, *decrease*, while a change from negative to positive lines of force is an *increase*.

We are in a position now to see clearly that, to make a machine to produce electricity, the only thing necessary

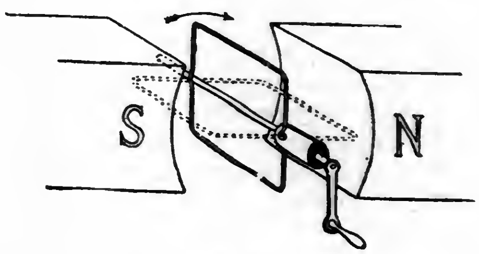


Fig. 9.

is to mount a coil between the poles of a magnet and revolve it; in other words, to make some such apparatus as that shown in fig. 9.

But a difficulty presents itself here, for, as a slight consideration will show, the current produced will be in one direction during one-half a revolution and in the other

direction during the other half. To see this clearly, let us follow the coil through one revolution.

In the position shown, the coil evidently embraces the greatest possible number of lines of force that run from the north to the south pole, because its plane is perpendicular to their direction. If, now, we rotate the coil through one-quarter of a revolution, its plane will then lie parallel to the lines of force but will embrace none whatever, so that during this quarter revolution the number of lines embraced has decreased, and, therefore, a current must traverse the wire in a certain direction. If the revolution be continued, the coil (looking at the same side) will begin to embrace lines of force coming from the south pole, and, as these are negative lines of force and increase in number as the revolution progresses, the current produced in the coils will continue in the same direction, because, as explained above, increase of negative lines of force has the same effect as decrease of positive lines. When the second quarter revolution has been completed the coil will stand in a position the reverse of that shown, and it will embrace (looking at the same side of the coil) the greatest possible number of negative lines. Continuing the revolution, we see that the number of negative lines will at once begin to decrease, so that the current will now be reversed, and this will continue until the end of the third quarter, when the plane of the coil will lie parallel to the lines of force and embrace none whatever; and it will also continue during the fourth and last quarter revolution, during which the coil will embrace an increasing number of positive lines, until it reaches the original position shown, when it will again embrace the maximum number of positive lines. The same succession of phenomena will clearly follow every succeeding revolution, and an alternating current will be generated, being in one direction during the first half of each revolution and in the opposite direction during the latter half.

To make these alternating currents produce a continuous current in a wire outside the machine, the simple

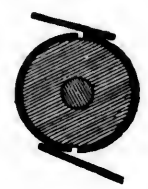


Fig. 10.

device shown in fig. 10 and called a "commutator" was invented, in which the interior portion indicates the shaft carrying the coil, the curved lines indicate two brass segments separately secured to the shaft, and the two straight lines represent brass stops or "brushes," which press upon these segments. The two ends of the coil are connected respectively to the two brass segments, while the two ends of the outside wire are connected respectively to the two brass "brushes;" and, as these brushes are stationary while the shaft revolves, the brushes interchange segments twice in each revolution, so that just as the current coming into one brush from one segment is about to change, the other segment comes under the brush; therefore, the current given to the brush is always in the same direction, though the current in the revolving coil continues to alternate.

(TO BE CONTINUED.)

METALLIC TIES ON EUROPEAN RAILROADS.

THE second question on the programme of the International Railroad Congress at Milan is as follows: "What conclusion can be drawn from the double point of view of economy and of technical success, of the latest results obtained by the use of metallic ties?"

In answer to this question, four documents have been submitted, an analysis of which has been made by M. A. M. Kowalski, Chief Engineer of the Bone-Guelme Line in Algeria. The documents are:

1. A report of the company operating the Netherlands State Railroads.

2. A note from the Eastern Railroad of France.

3. A note from the administration of the Belgian State Railroads.

4. A report, with map, of the French Ministry of Public Works.

A summary of these documents is given below:

I. THE NETHERLANDS STATE RAILROAD.

The note of the Netherlands State Railroad Company gives experience for 22 years. In 1865, this company put on the Deventer-Zwolle line 10,000 metallic ties of the Cosijn system, consisting simply of a rolled iron beam of an H form laid flat, measuring 2.70 meters in length and 20 centimeters in breadth, and weighing 56.7 kilometers each; the rail of iron, weighing 38 kilogrammes to the meter, was placed upon oak blocks raised on this tie and having an inclination of 1 in 20. The rail was fastened simply by bolts. This system is shown in fig. 1.

This tie, although somewhat primitive and not presenting any of the qualities which are now considered essential for metallic ties, has done excellent service. Although the traffic is quite large, amounting from 12 to 16 trains a day, after 22 years of service there still remain in the track 9,547, or 95½ per cent., of the 10,000 originally laid.

In 1880, this company, encouraged by the success of the preceding experiment, decided to undertake a careful study of the question of metallic ties, profiting each year by the results obtained to introduce new improvements. (Some account of the experiments undertaken by this company was given in the RAILROAD AND ENGINEERING JOURNAL for August last, page 365.)

The note furnished by this company gives, in detail, the programme of these experiments, which have resulted from 1881 up to January 1, 1887, in putting in the track of 124,000 metallic ties of 9 different types.

The weight of the ties has been continually increased; from 40 kilogrammes for those used in 1881, which were of rolled iron, it has increased to 50 kilogrammes in 1883, for a steel tie and to 55 kilogrammes in those last tried, which are of steel, rolled to a varying profile and thickness.

The system which the company has finally adopted is that designed by its Chief Engineer of Maintenance of Way, M. Post. This tie is of the type shown in fig. 2. It presents with a few modifications, which practice has caused to be adopted, the following characteristics:

Material, mild steel. Form, section of U reversed, of variable width; the ends bent down. Length, 2.55 to 2.65 meters (8⅓ to 8½ ft.). Weight, 50 to 55 kilogrammes (110 to 121 lbs.). Fastenings—bolts and nuts of steel with eccentric heads, giving about 16 millimeters of bearing; stop-washers interposed between the bolts and the nuts. The weight of the fastenings is about 3.5 kilogrammes (7½ lbs.)

Disposition of ties: 10 ties to the length of one 9-meter rail, or 13 to a 12-meter rail; rails weighing from 33.7 to 40 kilogrammes to the meter. Ballast—sand, cinders and gravel.

Weight of locomotives, 50 to 68 tons; maximum weight on the axle, 14 tons; maximum speed of trains, 75 kilometers an hour.

Fig. 1

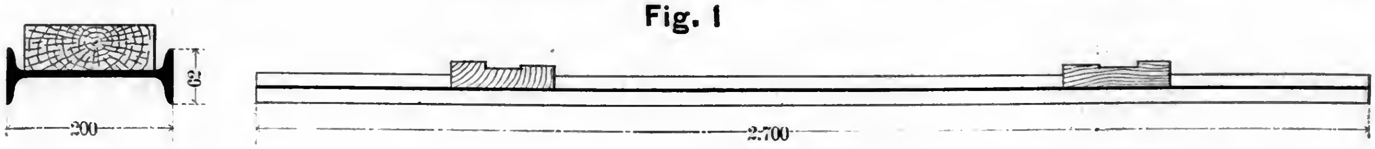


Fig. 2.

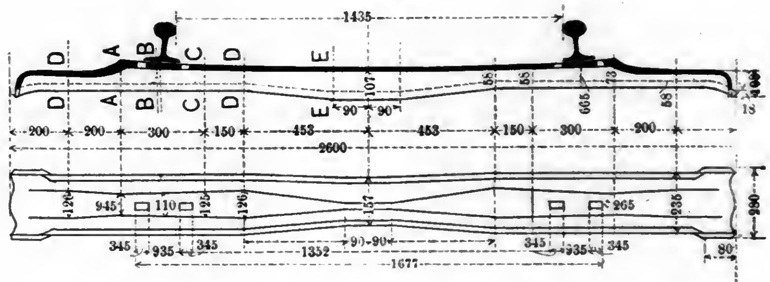


Fig. 3.

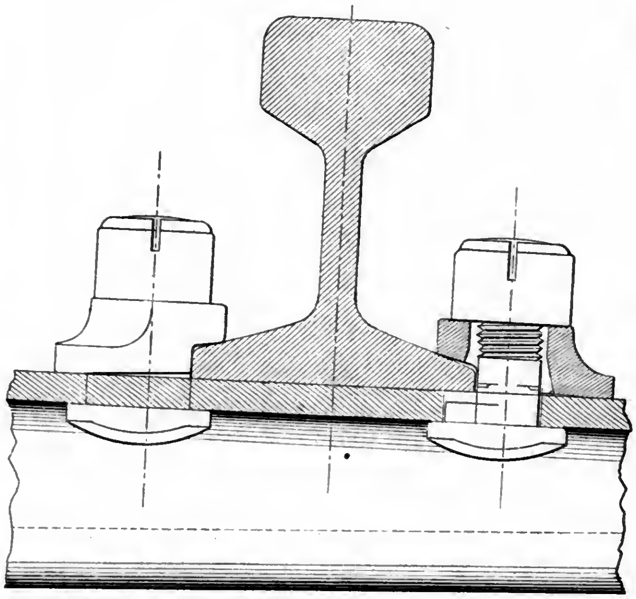
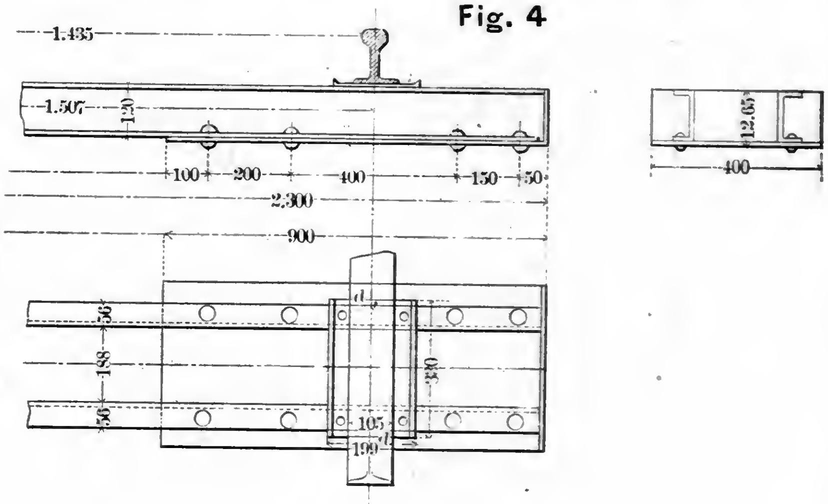


Fig. 4



TYPES OF STEEL TIES USED IN EUROPE.

Fig. 5

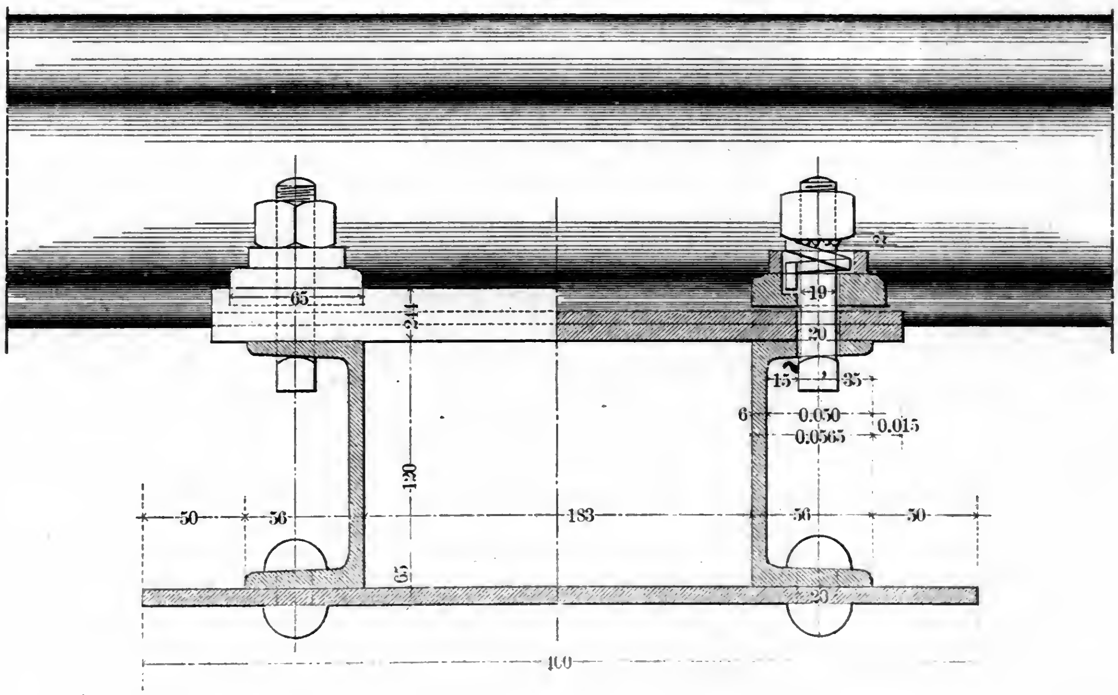
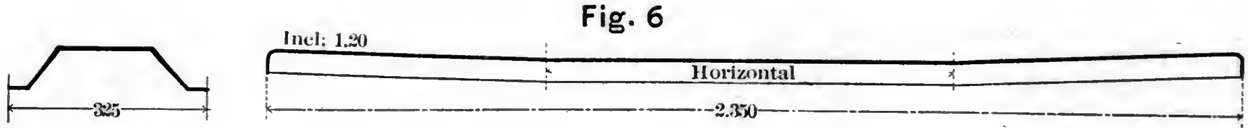


Fig. 6



Maximum radius of curvature, 350 meters (1,148 ft.) Maximum grade, 0.016.

Price of the ties,110 francs per ton at the mill, or 5½ to 6 francs per tie and 1 franc for the fastenings.

Fig. 3 shows the method of fastening adopted with the Post tie.

The practical results obtained with ties placed under these conditions are given in the company's note under the form of extensive statistical tables, which can be summed up as follows:

1. The maintenance of track upon the metallic ties is easier than on wooden ones, especially after two or three years. The company estimates that after three years a gang of four men, working 250 days in the year and having, therefore, 50 days to spare for other work, can keep in good condition 8 kilometers of track on the Post ties.

2. The stability is much greater; the line and surface of the rails is much better maintained.

3. When the ties are closed at the end, as in the Post pattern, there is no lateral displacement of the track.

4. Mild steel is much better for ties than rolled iron. The company considers it best to anneal the ties after the ends have been flanged or bent, without, however, considering this indispensable.

5. The fish-joints give good results.

6. The ballast packs down in the reversed bowl or cup which forms the interior of the tie and resists all movement.

II. THE EASTERN RAILROAD OF FRANCE.

The Eastern Railroad Company of France has recently begun to try a system of metallic ties, invented by M. Gillaume, Chief Engineer of the Company. This tie is composed of an iron beam the shape of a reversed U spread out somewhat at the base and turned down at the ends in order to resist lateral displacement. It is of a regular prismatic form. The rail is placed upon the ties on blocks of compressed wood, having an inclination of 1 in 20. It is fastened by steel clamps which take hold of the vertical surface of the tie. These clamps can be unfastened in such a way that the tie may be taken out without moving the rail.

The tie proper weighs 78 kilogrammes; the fastenings, 8.4 kilogrammes, a total of 86.4 kilogrammes (190 lbs.).

The experience of the Eastern Company is still of too short duration to enable its officers to form definite conclusions, and especially computing the comparative expense of maintenance with metallic ties or with wooden ties. Nevertheless, it can already be said that the results gained are satisfactory. The track is solid and does not require special care. The advantages which this company has recognized in this system of ties are as follows:

1. The point of resistance on the ballast is placed very low.

2. The tie accommodates itself to all kinds of ballast.

3. There is no contact between the foot of the rail and the metal of the tie, which avoids all corrosion or rusting.

4. The system of attachment is simple and requires neither rivets nor bolts.

5. The Eastern Company, nevertheless, estimates that, by reason of the long period of service which it obtains from its ties of creosoted oak (a period which is averaged at about 25 years). the substitution of metal for wood does not present any peculiar advantages.

III. THE BELGIAN STATE RAILROADS.

The management of the Belgian State railroads has sent to the Commission a note giving the history of numerous failures which have attended the trial of metallic ties on these roads from 1846 to 1885.

The continued unfavorable results shown by this note would lead one to adopt a conclusion adverse to the use of metallic ties, were it not that the different trials undertaken on this road show that the failures resulted either from inherent faults in the different systems tried or from faults in the material. It may also be said that none of these trials have been continued through periods sufficiently long to give real definite results.

It appears, indeed, that the management of the Belgian State railroads has not seen fit to condemn the principle of metallic ties altogether, since it decided, in 1885, to put into use 75,000 such ties of 3 new types. In this number are included 35,000 of the Post system, very much the same as those used on the Netherlands State Railroad; 35,000 of the system devised by M. Braet, Chief Engineer of track and bridge of the State Railroads, which is very similar to the Post type, but somewhat wider and with deeper flanges; 5,000 of the system devised by M. Bernard, Engineer of Maintenance of the Northern Railroad of Belgium. This third type is composed of two channel irons placed parallel at a distance of 188 millimeters apart, united at their bases by two iron plates placed at the end and fastened by rivets in such a way as to form a hollow trunk which is filled in with ballast and thus increases the resistance. The rail rests upon a chair, giving the inclination of 1 in 20, and, at the same time, securing it to the two channel irons. The fastening is made by bolts and nuts, which, at the same time, fix the chair to the tie. The lower face of the nut rests upon an elastic washer. The weight of the tie with the chairs is 105 kilogrammes (231 lbs.); the plates at the end are 40 centimeters long. With this system, 8 ties are used in each rail of 7 meters in length. Figs. 4 and 5 show this Bernard tie and, on a larger scale, the rail fastenings used with it.

IV. THE FRENCH MINISTRY OF PUBLIC WORKS.

The Ministry of Public Works of France has sent to the Commission an elaborate work by M. Brika, Chief Engineer of track and bridges for the French State Railroads. This report is divided into three parts; the first giving an account of the general development of metallic ties, since their first introduction, and the second describing the different types of ties which have been used and the different methods of fastening the rail, and the third giving some account of the extent to which they have been introduced into France. The larger number of ties used in France have been of the Vautherin type (shown in fig. 6) or modifications of it.

GENERAL CONCLUSIONS.

The documents which have been analyzed as above are the only ones on this question which have been addressed to the International Commission. In order to complete its work and to make possible comparisons between the results obtained on different railroads and under different conditions, the Commission has addressed questions to a number of Managements, but a *résumé* of the answers given in the table annexed to the report contains little that is new.

The question of the use of metallic ties was the subject of a long discussion before the first section of the Congress held at Brussels, and the conclusions reached by that section were again discussed before the full Congress, where the opinions of both parties—those who advocated metallic ties and those who advocated wooden ties—were put forward in the best possible manner. The conclusions of the Congress were, in substance, as follows:

"1. The Congress is of the opinion that track on metallic ties, considered from a technical point of view, can sustain a comparison with track on wooden ties quite as well on lines of the heaviest traffic as on those of light traffic. From the financial point of view no general comparison is yet possible, but a comparison must be made in each particular case, taking account of the price of materials, the cost of maintenance and the probable duration. The result of this comparison will show which type of tie is to be preferred in each case.

"2. The Congress is of opinion that for trunk lines of heavy traffic and for military or strategic lines a metallic tie should be used heavier and more strongly made than that which can be employed on branch and secondary lines, especially when there is no probability that these secondary lines are likely to become traffic lines in the near future. In this casethe cost of metallic ties for secondary lines will be very much less than is necessary to expend on the trunk lines.

"In relation to the best form and dimensions of the metallic tie, the Congress is of the opinion that the results obtained from experience are not yet sufficiently conclusive to justify it in recommending one type to the exclusion of all the others."

Since the last meeting of the Congress several companies have manifested much interest in this question. These companies have reported new ties laid of different patterns, either on trial or as an extension of previous use, as follows:

Eastern Railroad of France, on trial, 5,000 of the Paulet system; 10,000 of a type slightly changed from the Vantherin system and 20,000 of the Post system. This company is also about to make a trial of 5,000 ties of a new system, of steel. The Northern Railroad Company of France has put down on trial 15,000 iron ties of the old box type, and has ordered 10,0000 of the same system with some slight modifications. The Algerian Railroad has put down in renewals 20,000 of the Hilf system. The trials on the Belgian State Railroads and the Netherlands State Railroads have been noticed before. It may also be said that trials of metallic ties in small numbers are being made on the Swedish State Railroads, on the Hungarian State Railroads, on the Midland and on the Eastern roads in England and on several of the Spanish lines. In Germany, it is reported that 184,000 ties, mostly of the Post system, have been laid on different lines during the past two years, and in the Argentine Republic (where wood is scarce and costly) 112,000 ties of iron of the inverted U shape have been put in use.

As sub-issues or minor arguments in favor of the use of metallic ties which may be taken into account in deciding upon their use, it is noted that the Paris, Lyons & Mediterranean Company estimates that the use of metallic ties on the Algerian lines has enabled it to save about one-quarter of the labor required for maintenance. The Chief Engineer of this Company estimates the saving at about 500 francs per kilometer per year ($155 per mile). It is also noted that on the short line which a French Company is building in Senegal, on the coast of Africa, it has been found necessary to use metallic ties, as ties of the best oak brought from Europe were destroyed by white ants in less than three months. In these, as in many other cases, however, the question of the use of wood or metal must be decided wholly by local circumstances.

LOCOMOTIVE-BOILER EXPLOSIONS ON BRITISH RAILROADS.

THE reports of the Inspectors of the British Board of Trade have usually been fairly full and complete on locomotive-boiler explosions. Accidents of that class are, indeed, generally of considerable importance in their results, almost invariably causing loss of life, or at least serious injury, to persons, and much destruction of property. They are, moreover, not of very frequent occurrence and do not come to be accepted and passed over as a matter of course, like some other kinds of accidents.

A summary of the Inspectors' reports on the explosions of locomotive boilers, as made to the Board of Trade for a series of years, may therefore be expected to show some interesting facts, and, perhaps, to throw incidentally some light on doubtful or disputed points.

Such a summary is begun below, and will be continued up to the present time in following numbers of the JOUNAL.

The Inspectors' reports, as has been heretofore noted, are made by experts who are continually employed in this work, and who are, moreover, invested by law with power to examine witnesses and use other methods of arriving at the causes of accidents. They possess, therefore, not only an official character, but also the weight attaching to experience and knowledge of the subject of which they treat.

INSPECTORS' REPORTS.

March 6, 1853, the boiler of a locomotive on the London & Northwestern exploded in the engine-shed at Longsight, killing 6 persons who were on or about the engine. The engine had been under repair and was just ready to go out for the first time. The fire was lighted early in the morning, and just before the explosion steam had been blowing off slightly. The safety valve was said to have been set at 70 lbs. The explosion was confined to the rear end of the boiler around the fire-box, the barrel and tubes remaining intact, and its effects were chiefly on the left side. The outer iron shell was entirely torn off; a piece 3 ft. by 4 ft. was blown out of the left side, drawing with it the iron stays out of the copper fire-box, into which they were screwed. The driving-wheel on that side was blown off, the axle breaking at the crank. The whole of the boiler plate, over the crown-sheet of the fire-box, was torn off and doubled up in the form of an S. The engine was a light one and had for several years been used chiefly as a pilot engine, not being heavy enough for the ordinary trains. The boiler barrel was of $\frac{5}{16}$-in. iron plates, 42-in. diameter and 8 ft. long, with 149 tubes, 1¾ in. diameter. The outer fire-box (which gave way) was of iron, ⅜-in. plates and 42 by 50 in. The water-spaces were 2½ in. wide, and the fire-box was of copper. The engine was built in 1840, and in 1842 had 33 new fire-box stays put in; in 1846, a new set of tubes. It does not appear, however, that the fire-box had ever been removed in 13 years. The Inspector found the copper fire-box in good condition and very little reduced by wear. The outer iron shell, however, was found pitted by corrosion in many places and eaten away in rings around the stay-bolts. The stay-bolts were extraordinary specimens of corrosion, being thickly incrusted with oxide in some parts and in others greatly reduced in thickness. Most of these stays remained attached to the iron plate and were drawn out of the copper, but a few remained with the copper, and some were broken off. It was also found that 11 of the tubes were nearly choked with a deposit of sulphate of lime. The Inspector does not think that there was any extraordinary or unusual pressure on the boiler, but believes the explosion to be due to the corrosion of the outer sheet and the weakening of the stays from the same cause.

March 17, 1853, the boiler of a locomotive on the London, Brighton & South Coast road exploded at Brighton while the engine was waiting to go out with a train. The engine had come the day before from the shops, where it had received slight repairs, and while there the fire-box casing had been taken off and the fire-box examined and found all right. The evidence was that the boiler had plenty of water a few minutes before the explosion. There were two-safety-valves, one on the dome, the other on the fire-box; both were set at 80 lbs. in the shop, but it is said that the driver had screwed the dome valve down to 100 lbs. The valves were both blowing just before the explosion. The engine was a small tank engine with 12 by 18-in. cylinders, one pair of drivers (66 in.) and leading and trailing wheels 42 in. diameter. The boiler-barrel was 40 in. diameter and 8 ft. long, with 101 tubes, 2 in. diameter. It was built in 1840, had new tubes in 1844 and a new fire-box in 1848. The explosion tore open the barrel, and several pieces of iron were torn out from the sheets. The fire-box was bent out of shape, but not torn, and most of the stays were good. The plates (iron) were found to be generally full $\frac{5}{16}$ in., but in some places were reduced by slight corrosion to ¼ in. The boiler was made of four plates carried lengthwise along the boiler and single-riveted. The original thickness of the plates was ⅜ in. in the barrel and $\frac{7}{16}$ in. in the outer fire-box. The Inspector thinks that the explosion was due to weakening of the plates by corrosion and to excessive pressure; he also thinks that the construction and design of the boiler was not of the best class.

January 8, 1854, the boiler of a locomotive on the Midland Railway exploded near Bristol. The train (freight) had stalled on a grade, and the engine was just preparing

to go on with part of it when the explosion took place. The engineer and fireman hardly heard it, although a loud noise was heard by people some distance away. The boiler ripped open along a line near the top, the dome and part of the shell being torn off and thrown nearly a quarter of a mile away. The engine was about nine years old; it had 16 by 21-in. cylinders and six-coupled wheels, 60 in. diameter. The fire-box heating surface was 72 and the tubes 750 sq. ft. There were two safety-valves, $3\frac{1}{16}$ in. diameter. The Inspector found that the boiler was in good condition, and thought this a clear case of low water and too rapid generation of steam, the top of the fire-box being probably heated red-hot.

In connection with this accident the Inspector adds: "In considering the explosion I was led to make some experiments to determine what is the smallest aperture requisite for a safety-valve. In the engine experimented on, the area of the heating surface of the fire-box was 162 sq. ft.; tube surface, 1,757 sq. ft.; making a total of 1,919 sq. ft. The grate area was 25.47 sq. ft. The pressures were shown by a Bourdon pressure gauge. The area of the orifice required to keep the steam in the boiler at a given pressure was:

100 lbs.	0.65 sq. in.
80 "	0.75 "
60 "	1.06 "
40 "	1.60 "
20 "	3.00 "

"Hence, the area diminishes as the pressure increases. I have assumed the following formula from these results, in which is included the grate area (G), the fire-box heating surface (S), the pressure of steam (P) and a constant quantity (C) derived from these experiments. I have omitted the tube heating surface, because the experiments were made when the engine was at rest and the tube surface comparatively inactive; besides, the safety-valves are intended to provide for the safety of a boiler at rest. Then, if D=the diameter of aperture of valve, the formula will be:

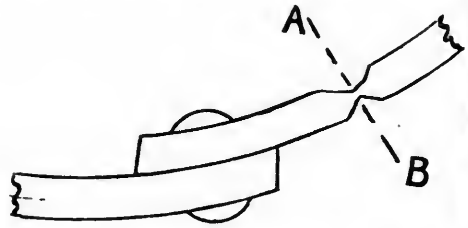
$$D = \frac{S}{PG} \times C$$

"If it be assumed that the valve is lifted $\frac{1}{16}$ in. to admit of the escape of steam, and making use of the data derived from the experiments; and if D be in inches, S and G in feet and P in pounds, the constant C may be taken as 51."

February 7, 1825, the boiler of the engine *Actæon* on the Great Western Railway exploded at Gloucester. The train had stopped at that station, and the engine had put two cars on a siding and was backing up to the train when the explosion took place; the engineer had just shut off steam. The effect of the explosion was to blow off both safety valves, throwing them some 90 ft. away. The iron ring of the foot-stay, weighing about 100 lbs. was thrown 900 ft. and then broke through the wall of a house. The bottom half of the boiler barrel was forced down and broke the driving-axle, while the upper half of the barrel was blown off in one piece, which measured about $8\frac{1}{2}$ by $6\frac{1}{2}$ ft. and weighed nearly 700 lbs. The engine was built in 1841 and was thoroughly overhauled and new tubes put in in 1850. The mileage with the first set of tubes was 150,939; with the second, 106,433. The barrel of the boiler was 8 ft. 6 in. long and was of $\frac{5}{16}$-in. iron in four plates, each about 2 ft. wide, bent lengthwise around the cylinder, but not breaking joints. An examination showed the inside of the bottom plates to be deeply pitted with many small indentations, and along the seam on the right-hand side there was a deep channel eaten away, reducing the thickness of the plate at some points to 0.1 in. As the explosion started at this point, the conclusion was reached that the explosion was caused by the plate being so much reduced in thickness that it was no longer able to withstand the pressure.

This case being referred to Professor Tyndall for his opinion, he replied that the corrosion was very probably due to electric action caused by the iron shell and brass tubes. From the action of this voltaic couple, some decomposition of the water would take place, hydrogen being liberated against the brass and oxygen (acid also, if the water contained salts in solution) against the iron plates. This action, though feeble, would, if continued for several years, be sufficient to explain the corrosion of the plates.

April 5, 1855, the boiler of a locomotive on the Caledonian road exploded while the engine was standing in the shed at Greenock. The engine was seven years old and had run about 227,000 miles in all; the boiler barrel was 42 in. diameter and 10 ft. long, of $\frac{3}{8}$-in. iron, in three plates, each forming a ring, and the rivet lines breaking joints. The engine was lifted by the explosion and thrown over on its side; two men in the shed were scalded. The boiler gave way near the bottom, where there was a line of corrosion very similar to that described in the *Actæon* case above. The appearance of the plate in section is shown in the accompanying diagram, in which



A B is the line of fracture. As far as could be seen the bottom of the boiler was badly pitted. The remarkable point in this case was that there was a line of indentation or corrosion on the outside of the plate, corresponding to that on the inside. The explosion was attributed to the weakening of the plate by corrosion.

April 5, 1855, the boiler of a locomotive on the London & Northwestern exploded in the shed at Rugby. The entire cylindrical cover was torn off, one piece, weighing 1,000 lbs., being thrown a distance of 750 ft. The boiler, so far as could be ascertained, was in good order and the iron of good quality. The only cause for the explosion that could be ascertained was that a careless or ignorant helper in the shed had screwed down the sa ety-valve, allowing the pressure in the boiler to become excessive. The foreman in the shed was censured for allowing such a thing to be done.

July 14, 1855, a locomotive on the North London Railway exploded its boiler while standing at the Camden Town Station. The barrel of the boiler was torn off, leaving the tubes exposed. The examination showed that the throat-sheet, connecting the barrel with the outside fire-box, was very defective, showing signs of bad welding, and that this plate had been further damaged by bending into shape. The plate was $\frac{3}{8}$ in. thick, and the explosion was undoubtedly due to its failure.

July 2, 1855, the boiler of a six-wheel-coupled freight engine on the South Yorkshire line exploded while the engine was standing at Aldam, or, to describe it more correctly, the crown-sheet of the fire-box collapsed. From examination, it appeared that this was a case of low water, the crown-sheet failing because of overheating.

April 7, 1856, the boiler of a locomotive on the Caledonian line exploded when the engine was near Carlisle. The engine-driver and fireman were killed. This was the rare case of a boiler exploding while the engine was running. The crown-sheet of the fire-box gave way, and the engine was lifted up from the track and turned over six times. As both men on the engine were killed and the engine itself almost completely demolished, the examination into this case was attended with difficulties. The conclusion finally reached was that there was excessive pressure, probably due to the fire-box crown becoming red-hot on account of low water, and the consequent sudden evolution of a large volume of steam of high pressure.

November 11, 1856, a locomotive on the Blyth & Tyne road exploded its boiler while standing in the yard. The engine was a very old one, used for shifting, and the boiler was of an antiquated pattern with a return flue and combustion chamber. It was probably a case of old age and complete wearing out.

January 19, 1857, the boiler of a locomotive attached to a ballast train on the Lancashire & Yorkshire road exploded while the train was standing on the track near

Sough. Nearly the whole of the segmental portion of the back end was blown out, tearing out 9 of the ⅞-in. stay-bolts which attached the back sheet to the fire-box. The sheet which gave way was originally ⅜ in. thick and was worn down to $\frac{5}{16}$ in. There was also evidence that the longitudinal stays were inoperative. The original condition of the fastenings of these stays is shown in fig. 1

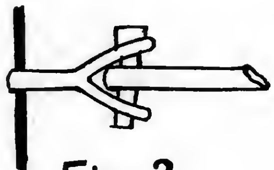


Fig. 2.

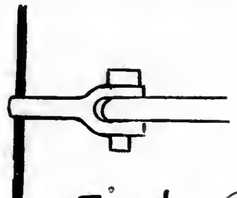


Fig. 1

herewith, but after the explosion they were found extended in the fork, as shown in fig. 2, and very much corroded. The explosion, however, was probably chiefly due to the worn and weak condition of the sheet.

March 6, 1857, the boiler of a shifting engine on the Midland line exploded in the yard at Birmingham. The external shell was torn into large fragments, some of which were thrown 150 ft.; one of them passed through the roof of a building and killed a workman there. This explosion was attributed to corrosion of the sheet, which was very apparent in the fragments.

April 9, 1857, the boiler of an engine on the Belfast & Ballymena road exploded in the yard at Belfast, just after it had coupled on to a train. In this case the fire-box collapsed, the crown-sheet being forced down against the tube-sheet, and the side and back sheets being torn away from the stay-bolts and doubled up; the outer back sheet, with the fire-door, was blown completely away. The crown-bars were 8 in number, 4½ by 2 in.; none of them were broken. One-half of them were attached to the external crown-sheet by hanging stays at each end; these retained their position, the stay-bolts being drawn out from the copper sheet. This was an undoubted case of low water and consequent overheating of the copper plates, with a sudden increase of steam pressure.

November 24, 1857, the boiler of a locomotive on the Southeastern road exploded as the engine was standing at the Greenwich Station, just ready to start. The crown-sheet of the fire-box was ripped along the line of the rivets, the rent extending along the side-plates. The engine was lifted up and thrown across the track. The exact age of the engine was unknown, but a new fire-box and tubes were put in in 1844 and new tubes again in 1854. The copper crown-sheet, originally ⅜ in. thick, was worn down to $\frac{3}{16}$ in., and the Inspector believes that the sheet failed from weakness, although the boiler pressure seems to have been only 65 lbs.

In this year's report, the Inspector makes the following general remarks: "In accounting for the effects of boiler explosions two facts appear generally to be lost sight of; the first is that after a rupture or rent is once made in the shell of a boiler a much less force is required to extend or continue it than the initial force producing the rupture. Therefore, when high-pressure steam forces for itself an opening through an attenuated part of the boiler plate, the same, or a less, pressure of steam will continue the rent through a part of the plate which may have suffered no attenuation. I would illustrate this by referring to the resistance which is met with in attempting to thrust the finger through a sheet of writing paper, which is considerable, but once the finger is through the whole hand passes without experiencing any further resistance.

"The second fact is that of the cumulative force of steam from its continuous action, as in a rocket. This is generally exhibited where the rupture occurs in the fire-box end of the boiler. The steam then continuously escaping drives the engine horizontally in an opposite direction, or, frequently, it mounts into the air and is carried a considerable distance, as in the Ballymena explosion, in one on the Caledonian Railway, near Carlisle, and in several other cases."

The earlier reports of explosions, while in many cases carefully made and well considered, are hardly so full or so interesting as those which will be found in later years, when the reports are accompanied by sketches and diagrams illustrating points in boiler construction. These sketches will be reproduced in their proper order.

(*To be continued.*)

STEAM FERRIES ON THE DANISH STATE RAILROADS.

(Abstract of note in the *Revue Générale des Chemins de Fer.*)

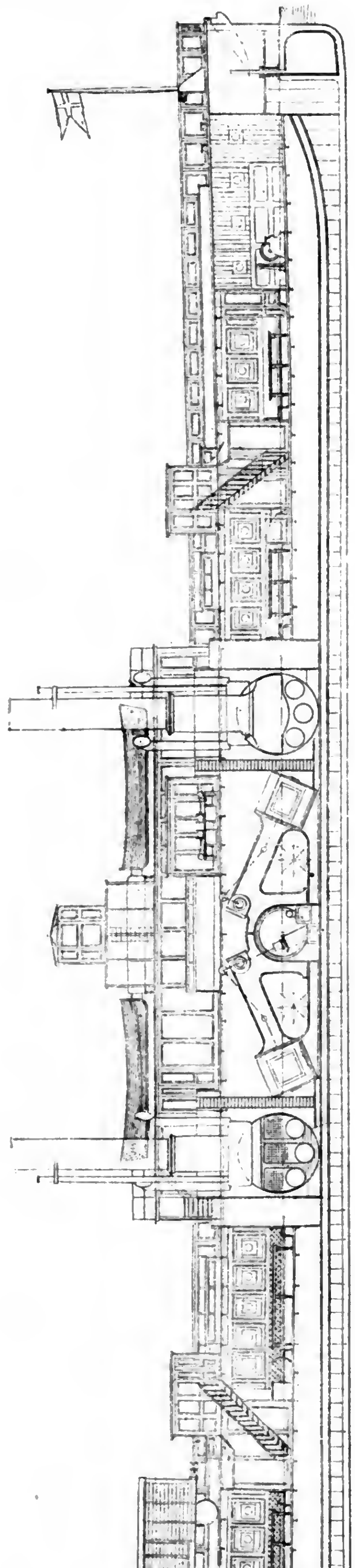
THE railroad system of Denmark is, by the geographical situation of the country, divided into four parts: the lines on the mainland (the peninsula of Jutland) and the lines on the three large islands of Zeeland, Funen and Falster. These islands are divided from the mainland by straits too wide and too deep to admit of the possibility of bridging them. The lines on the peninsula again are obliged to cross the deep arm of the sea known as the Limfiord, which cuts across the peninsula of Jutland near its northern end.

When the railroad system was first established, connection was made between the islands and the mainland by ordinary steamboats, which made it necessary to transfer all freight and caused great delays in traffic. In 1872, it was decided to try, on the ferry between Frederica and Strib across the Little Belt, which is only 1½ miles in width, a large steamboat on which it would be possible to carry loaded cars. For a number of years this kind of service was not extended to the more important transfers. It is only since 1883, after the complete success of the ferry on the Little Belt had been shown, that the use of steam ferry-boats became general across the straits and on the different railroad lines. This has now been done in such a manner that a carriage can pass from Copenhagen to any of the islands and to the extremity of the peninsula of Jutland without transfer.

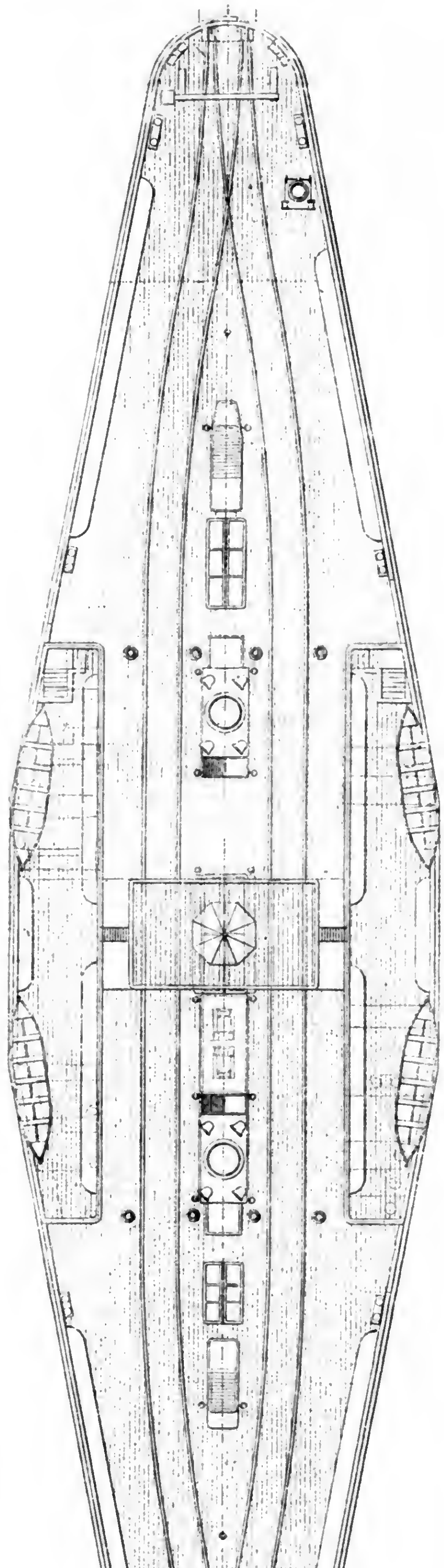
The ferries now actually in use are: The ferry across the Little Belt from Frederica to Strib, 1½ miles, mentioned above; the ferry across the Great Belt between Nyborg aod Korsor, 16½ miles in length, opened in November, 1883; the ferry from Masnedo on the island of Zeeland to Orehovd on the island of Falster, 2¼ miles, opened in January, 1884, and, lastly, the ferry across the Limfiord between Oddesund and South Oddesund, about 1¼ miles, opened in June, 1885.

In addition to this, a joint commission of Danish and Swedish engineers is now considering the question of completing the connection between Denmark and the Scandanavian peninsula by a steam ferry across the sound from Copenhagen to Malmo, with possibly also one from Frederikshavn to Gottenborg. It is also very probable that the North German Lloyd Company, which has now a service of express steamboats between Warnemunde in Prussia and Gjedson, forming part of a through line between Berlin and Copenhagen, may substitute steam ferry-boats for the ordinary steamers which it now uses.

In the transfer of cars from the railroad tracks to the tracks upon the deck of the ferry-boats, a movable landing-stage is necessary, and a dock must be used which will hold the boat itself in a fixed position. This has been provided for by the construction of decks, in which, by means of piles and planking, the form of the landing place is adjusted to that of the deck of the ferry-boat, while the movable landing stage is provided by a platform or dock supported by iron trusses and resting at one extremity on pivots and supported at the other end by heavy chains, hung from an iron truss or bridge. These supporting chains pass over pulleys on the truss and are carried thence to windlasses, by means of which the bridge can be raised and lowered. In the landing place at Nyborg, on the Great Belt, which is similar to all the others, the



LONGITUDINAL SECTION.



DECK PLAN.

STEAM FERRY-BOAT "NYBORG," DANISH STATE RAILROAD.

landing stage can be raised from an angle of 4° below the horizontal to one of 6° above; the stage being 18¼ meters in length, these extreme inclinations vary from a descending grade of 7½ per cent. to an ascent of 10 per cent. The cars are hauled up and down these inclined planes by means of a cable operated by a steam capstan on the deck of the boat. The dock and landing stage are so arranged, and the attachments are so convenient, that a steamer is brought into position in a very short time and can be fully loaded with cars in less than 10 minutes.

The form of the dock and the arrangement of the landing stage does not essentially differ from those used at the ferries on the Hudson River at New York, except in the substitution, to a great extent, of iron for wood in the construction.

The passage of the Great Belt, which is the longest ferry in use (16½ miles), is effected by two steamers, the *Nyborg* and the *Korsor*, which were designed by M. K. Neilson, Director of Naval Construction, and which were built in the Kockum ship-yard at Malmo in Sweden. A third ferry-boat of the same model is now being built by Burmeister & Wain at Copenhagen. The accompanying illustrations are a longitudinal section, a deck-plan and a cross section of one of these boats.

The hulls of these boats are of steel plates, and their construction is necessarily very solid, as they have to resist the bad weather to which they are often exposed in crossing the Great Belt.

Besides the ordinary keel, the hull carries two false or lateral keels in order to increase the stability. The bottom of the boat is nearly flat, as shown. It is necessary, in fact, that, with the load placed entirely on the deck, these boats should have much more stability than an ordinary vessel and this has been attained to such a degree that, when one of the tracks on the deck is loaded and the other empty, the inclination of the boat is less than 7°.

In order to increase the stability, the boats are provided with paddle-wheels instead of screws. These wheels are made of Swedish iron and are unusually heavy and strongly formed in order that they may not be injured when the navigation is interrupted by ice. There are two engines of the compound pattern, the four cylinders, two for each engine, acting upon the same shaft. Steam is furnished by four boilers, with corrugated fire-boxes on the Fox system. The dimensions of the engines are: High-pressure cylinder, 33.75 in. diameter; low-pressure cylinders, 63.25 in. diameter; stroke, 54 in. The admission of steam in the high-pressure cylinder can be varied from 0.2 to 0.6 of the stroke.

The principal dimensions of the boats are as follows: Length on deck, 250 ft.; greatest breadth on deck, 34 ft.; breadth over the paddle-wheels, 58 ft. The boats draw 8 ft. of water when unloaded and 9¼ ft. when carrying a full load of about 225 tons. The displacement of water when loaded is 1,295 tons. The engines, the dimensions of which we have given above, will work up to 1,500 H. P., and, with an ordinary load, the speed is 13 knots an hour.

On the deck of the boat are Harfield steam capstans for raising the anchor, steam capstans for hauling cars on board and Muir & Caldwell's steam steering apparatus. The boats are double-enders, with a rudder at each end, which can be fixed in place and serve as a stem; it is, therefore, not necessary to turn them.

The engine-room is lighted by electricity, and, in order to facilitate loading and unloading at night, the decks are lighted by arc electric lamps.

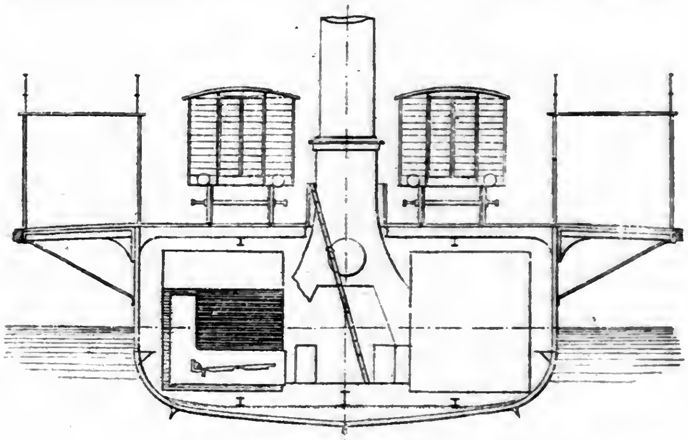
These ferry-boats are abundantly provided with safety apparatus and small boats specially constructed in order to resist the ice.

These ferry-boats are provided with all desirable comforts for travelers. The depth of 16¼ ft. between the deck beams and the bottom timbers allows a height of 10 ft. for the cabins, and they are spacious and well furnished. They are heated and ventilated by special apparatus, the heat being obtained from steam pipes which derive their steam from the large boilers, and the ventilation is effected by blowers which supply fresh air, which is warmed in winter. The impure air is carried off by special shafts. The walls of these cabins are panels of maple and walnut, and the furniture is of maple upholstered with red velvet.

The deck of the ferry-boat shown in the illustration carries two tracks. Each of these tracks can hold 8 freight cars of the pattern in use on the Danish railroads, but it is found that it is not often necessary to take 16 cars at a trip. At each end of the deck the two tracks unite in one which, at the landing, corresponds with that on the landing stage.

When the cars have been run upon the deck they are secured by means of clamps, one end of which is fastened to the buffer and the other to the rail. A screw attached to the clamp permits sufficient tension to be put on to prevent the cars from moving.

Where there is only a single track upon the deck, as in the boats used at the Little Belt ferry, the embarkation of the cars is very easily managed, as they are simply drawn upon the boat by the steam capstans. The use of the two tracks on the larger boats, however, requires some care in manœuvering the cars upon the curves near the ends, as one of the buffers might escape from contact with the buffer on the preceding car. To avoid accidents and derailments, the buffers at the rear of each car are covered during the loading with a strong wooden beam, making a continuous surface upon which the buffer of the following car can bear without any danger of slipping out of contact.



CROSS SECTION.
STEAM FERRY-BOAT "NYBORG."

As a general rule, these boats carry only the freight-cars, the baggage and the mail cars and special cars (such as the private cars of the royal family and others). Passengers descend from the train, which is run upon a switch close to the dock, and enter the cabin of the boat; when the passage is over they enter another train which waits for them at the landing. The crossing of the Great Belt lasts an hour and a quarter, usually, and delay is very rare, even in bad weather.

The service at the Little Belt is carried on by two smaller ferry-boats named *Hjalmar* and *Ingeborg*, which were built in the Shickatt ship-yards at Elbing in Prussia. The general pattern of these boats is very similar to the larger ones, but they are only 164 ft. in length on deck and are provided with a single track only. The motive power is one compound engine. The speed is about 10 knots an hour; the passage being very much shorter than at the Great Belt, this speed is sufficient, as these smaller boats can transfer during a given time quite as many cars as the larger boats used on the longer ferry.

The service on the other ferries is carried on by boats similar to those used on the Little Belt.

The passage of the Great Belt is rarely interrupted by ice, the sea being open, but in the narrow strait of the Little Belt ice is often driven by wind into masses which freeze together in heavy cakes and cause delays. In order to open the passage a twin-screw boat (the *Valdemar*), with very powerful engines, has been built for the special purpose of breaking up the ice. This boat was not completed until the fall of 1886, and the following winter having been mild she has not been fully tested. It is expected that she will be able to break through ice 6 to 8 in. in thickness.

The steam ferry-boats and other vessels which are used to connect the different Danish lines belong to the Government, and their management is under the charge of a special division of the State railroad management, which is called the Maritime Department. The Chief of this department is Captain F. de Bardenfleth, who is assisted by M. Elmquist, Inspector of Vessels, and John Prior, Inspector of Machinery.

THE NEW WARSHIPS.

THE report of the Secretary of the Navy, to be presented to Congress on its meeting in December, will, it is stated, refer at length to the progress so far made in building a new navy.

For the benefit of the next Congress, it is understood Secretary Whitney will have prepared by the Bureau of Construction and Repairs elaborate descriptions of every vessel now building or the plans for which have been agreed upon. This will include the five great monitors, the cruisers, gun-boats, plans for harbor defense, the armored battle-ship and cruiser, the pneumatic dynamite gunboat and the torpedo-boat.

THE ARMORED BATTLE-SHIP.

The Board of officers which was appointed to estimate the cost of building the armored battle-ship designed by the Barrow Shipbuilding Company, of England, has completed its labors. The last estimates for constructing the hull and fittings are $1,890,000, and for engines and machinery $486,000, making a total of $2,376,000, which is $124,000 less than the sum appropriated by Congress for the purpose.

The report of the Board has been presented to Secretary Whitney. Some slight alterations in the original plans are suggested, but they are not radical. The vessel is to have triple-expansion engines with forced draft intended for the speed of 18 knots. The estimates include a full equipment, such as rigging, sails, anchors, etc. The most important recommendation is that the vessel be built at the Norfolk Navy Yard. It was generally believed that the New York Navy Yard would be selected for the work, but this recommendation, if approved by the Secretary, will probably result in the building of the six-thousand-ton armored cruiser designed by the Navy Department, instead of the battle-ship, at the New York yard. It is believed that it will take about 18 months to build the vessel at Norfolk.

The allowance of $75,000, which was made for the purchase of new plant for this yard, is not large enough, by about $50,000, for a complete equipment, but by the use of temporary sheds it is believed that the work of constructing the great ship can be carried on until Congress provides for the erection of suitable permanent shops. The construction work will be under the immediate direction of Naval Constructor Bowles, and the machine and engine work under that of Chief Engineer Robey.

The following instructions were, September 30, addressed to the Commandant of the New York Navy Yard: "The Department having decided that one of the two sea-going double-bottomed armored vessels appropriated for under the act approved August 3, 1886, shall be built at the yard under your command, the Bureau directs that preparations to that end be immediately made. The report of Assistant Naval Constructor F. T. Bowles to you under date of July 11, and the reports of the Board of which Captain G. C. Remey, U. S. N., was President, ordered by you under date of July 12 and of August 3, 1887, are approved. The Chief of the Bureau of Yards and Docks approves the location of the temporary sheds to cover the tools and machinery, and they will be erected by and at the expense of this Bureau."

To the Commandant of the Norfolk Navy Yard, a letter was addressed, similar in terms to the above, with the exception that it approves the report of Constructor Samuel H. Pook relative to the general arrangements and location of the tools and machinery for the execution of the work at that yard.

COAST AND HARBOR DEFENSE.

In the Naval Appropriation bill passed last March, provision was made for the expenditure of $2,000,000 for floating batteries or rams or other naval structures, to be used for coast and harbor defense. Secretary Whitney appointed a Board of Naval officers to consider the best method of expending this money, and, it is understood, they are ready to submit a report. This report has not been made public, but it is said that its recommendations are about as given below:

Monitors with the heaviest guns that can be mounted are to be the principal reliance for offensive and defensive warfare. About them, as auxiliary means of attack, are to be grouped armored torpedo-boats fitted with rams, sub-aqueous torpedo-boats and the ordinary first-class torpedo-boats.

It will be remembered that the Fortification Board recommended the construction of floating batteries. The unfinished double-turreted monitors, *Amphitrite*, *Monadnock*, *Puritan*, *Terror* and *Miantonomoh*, it was found, would, if finished with modern appliances, furnish the main reliance for coast defense. The improvement in heavy ordnance is such that land fortifications can hardly be relied upon to repel the attack of an invading fleet. Floating batteries would be a necessity, and none have been found more effective than the monitor type, with a turret the very minimum of size as an object to be fired at, while, as a defensive vessel, it can carry the heaviest guns that can be mounted.

The objects against which a naval attack would be directed are the important commercial ports, where vessels in the foreign trade must be protected, as well as the cities which are railroad and financial centers, and, therefore, demand such protection. The long-range fire could only be properly resisted by vessels of equal strength with those of the enemy. Indeed, the monitors could be armored more heavily and armed with heavier guns than any probable adversary. Of considerably less draft than the armored sea-going ship, they could, by operating among the shoals, avoid ramming and even torpedoes.

To gain such advantages, speed must be sacrificed, but it is quite evident that, for the defense of harbors and bays, the advantages of extra thickness of armor and of superior power of gun more than compensate for that loss.

But the plan now being carried out does not stop at a system of defensive warfare. The *Puritan* is a type of the class of sea-going monitors and is now being completed. She will carry four 10-in. guns and have 50 in. of freeboard. Her coaling capacity will be 400 tons, enough to steam with from New York to Panama and have sufficient left to manœver the vessel in a fight. She will be able to carry 100 rounds for each gun and will be supplied with torpedo nets and very heavy machine-gun batteries.

It is not generally considered possible to bar the progress of an armored fleet by the severe fire of the battery. It was necessary, therefore, that the monitors should have accessories, and it was to provide them that Congress appropriated $2,000,000, exclusive of the cost of armament. Each monitor will have as such accessories from 8 to 10 torpedo-boats, rams and sub-aqueous torpedo-boats.

The second feature of the accessory plan is the armored torpedo-boat, which may, perhaps, be better understood as a monitor without a turret, so built that it will deflect shots from the largest guns, make great speed, and, being fitted with rams, will also be capable of destroying the netting which surrounds armored vessels while it moves directly against the side of an enemy's vessel. These boats will also be so planned as to carry, if necessary, dynamite-guns throwing the aerial torpedo. In this way the armed torpedo-boat will be fitted to explode in every conceivable way the most destructive material known to modern warefare.

The third feature of the auxiliary plan is the employment of first-class torpedo boats in conjunction with the armored torpedo-boats, so that, while the latter may make it possible to reach the sides of the vessels of an attacking fleet, the swift torpedo-boats may take advantage of the work and surround the vessel attacked. Of this class, it is proposed to have from 4 to 6 for each monitor. In this way the floating battery of massive steel and iron will

be able to go out and meet the enemy, and, accompanied by a little fleet carrying the most destructive implements and material that invention has yet provided, give battle to the invading vessels so effectually as to make the safety of all of our great harbors and bays practically assured.

The Secretary of the Navy has approved the recommendation of the Board and accepted the proposition of the Pneumatic Gun Carriage & Power Company to furnish pneumatic carriages for the guns of one of the monitors, and also to furnish pneumatic apparatus for elevating and revolving the turrets, steering and ventilating the monitor *Terror*.

The advantages of the pneumatic system are set forth as follows, in a letter addressed to the Secretary of the Navy by the company:

"Compared with gun-carriages now worked by hand, and the few operated by steam and hydraulic power, the pneumatic system presents the distinct advantages herein set forth. In addition to the disadvantages of steam machinery for working guns, as stated by the Naval Board, the hydraulic recoil check must be employed therewith (as with the hand-worked carriages) with its uncertainty of pressures, and necessitating mechanical devices for holding the gun in battery, and also having no elastic cushion, subjecting the carriage to violent shocks on the return recoil in a sea-way, notwithstanding the buffers used to lessen the shock. In the system herewith described, the short recoil of naval guns is taken up by air at high-pressure in the recoil-cylinders, hereinafter described in detail; the compressed air for training and elevating the gun is carried at a constant pressure of 100 lbs. to the square inch, while that in the recoil-cylinders is held at a pressure of about 500 lbs., being supplied from an additional receiver below decks; when the gun recoils, the full effect of this elastic and increasing pressure is exerted in front of the pistons, until the counter-recoil begins, when the pressure is equalized automatically on both sides of the piston, and the gun returns to battery by its own weight without shock, and is held there by the pressure. In case of accident to the pneumatic supply, the traversing and elevating can be operated by hand, while any leakage from the recoil-cylinders is amply compensated for by the volume of air at atmospheric pressure pumped in by the cylinders themselves at each discharge of the gun. Furthermore, in the extreme case of unusual leakage and accident to the pumping engines, the recoil-cylinders can be charged from portable air flasks. The traversing, elevating and loading are accomplished by the means shown with great rapidity, giving a maximum of efficiency of the gun with a greatly reduced crew. The valve movement of the air engines for training and elevating permits of rapid motion in either direction, and of holding the gun fixed at any point. The elevating gear moves parallel with the recoil of the top carriage, and, the connection to the elevating band being elastic, the gear is not subject to injurious shocks. The loader (with sponge-head) can be attached to the rear of the carriage where deck space permits, or can be retained at any convenient point, and the carriage trained rapidly to it for loading. After receiving the shell or cartridge from a truck bearer, one movement of a lever elevates the loader to the proper angle and extends it into the gun-chamber; the reverse movement withdraws and levels it. The actuating machinery and connections are not exposed, but are located between the brackets underneath the gun—the extreme width of carriage and gears being much less than in the corresponding Government carriage. We have, by these means, utilized and practically applied to the working of guns of any size the evident advantages of compressed air, which can be easily carried at any desired pressure by use of the normal steam pressure in a vessel of war, and which is cool, clean, free from condensation or freezing, and, above all, furnishes an elastic cushion at any desired high-pressure for resisting the shock of recoil and counter-recoil without injuring the carriage."

STEEL GUN FORGINGS.

The Midvale Steel Works, of Philadelphia, were the only bidders for furnishing the 22 sets of steel forgings for the 6-in. breech-loading rifled guns, oil-treated and annealed, proposals for which were closed September 27. Two bids were submitted by this firm—one for supplying the forgings rough-bored and turned, oil-treated and annealed at $123,284; and the other for supplying the forgings, with tubes, jackets and trunnions, to be rough-bored and turned by the Navy Department, and the other work by the contractor, at $108,799. About 156 tons of forgings are involved in this contract. According to the terms of the contract to be entered into, the contractor must furnish one set of the forgings not later than December 31 next, and not less than one set every 15 days thereafter, the delivery to be completed within 15 months from the date of contract. The work of fabrication of the guns, for which these forgings are intended, will be performed at the Washington Ordnance Foundry. The guns are intended for the new vessels now building.

THE DYNAMITE GUN.

In addition to the public test of Lieutenant Zalinski's pneumatic dynamite gun, noted last month, some further tests were made early in October. These trials were intended to further determine the question of its accuracy of fire. Ten shots were fired, each projectile being loaded with 55 lbs. of sand, and weighing altogether 140 lbs. Firing commenced at 10.42 A. M. on this series and ended at 10.52.30, showing a rapidity of fire of about one shot a minute. The elevation throughout was 14°56′.

The next shot, at an elevation of 32°42′, had a range of over 2½ miles, falling close to the shore of Norton's Point. In this case, the projectile was charged with 100 lbs. of sand (representing gelatine), the whole missile weighing 203 lbs. The time taken in the flight of this shot was 24½ seconds, the initial pressure of compressed air being 975 lbs. per square inch and the final pressure 525 lbs.

The experiments closed with two shots, with an elevation of 15°, using 100-lb. projectiles, weighing in all 203 lbs. each. The gun was sighted for 15 yards to the left, and the shots fell within 3 yards to the left. The first projectile was 10 seconds in flight; initial pressure, 750 lbs.; final pressure, 625 lbs. The second shot was 9.04 seconds in the air; initial pressure, 750 lbs.; final pressure, 615 lbs. Range, 1,772 yards.

The shots were fired from the experimental gun at Fort Lafayette in the midst of pouring rain.

Of the time shells fired, two fell short 50 and 70 yards. Six would have hit a target of the size of the *Silliman* (the vessel used as a target in the first trial), and two others would have exploded sufficiently near to have injured her seriously. This was the first time that rapid firing with a large number of shells was attempted, and the experience indicated a modification in the arrangements of connection between the storage reservoirs and the gun. This is easily remedied. Lieutenant Zalinski ascribes the short range of two of the shells to this cause. He thinks, with the changes to be made, he could improve the record made, excellent as it seems to us, and as it appeared to impress the foreign officers who witnessed the experiments. Lieutenant Zalinski thinks that the dynamite cruiser guns can be fired at the rate of twice a minute. The contract calls for a rapidity of fire of once in two minutes.

At a distance of about 1,800 yards from the old fort, a small boat was made fast to a buoy, the two combined serving as a target.

A Sham Torpedo Battle.

(From the New York *Herald*.)

THE torpedo attack on the cruiser *Atlanta*, which took place in the harbor at Newport, R. I., on the evening of October 11, resulted in a victory for the defense, the *Atlanta*. So judged the umpires when the fight was finished, and so said all who were in a position to gauge fairly the friendly battle.

Thus has been given another partial solution of the naval war problem which has for its factors the ship and the torpedo. Neither abroad nor at home has this great tactical question been settled. After all, the one vigorous disagreement between the opinions of naval experts

is whether in high-sea duels and in fleet engagements the torpedo is or is not to replace armored battle ships and their unarmored auxiliaries.

The cruiser *Atlanta* as the target, and the torpedo flotilla of the other vessels of the squadron as the missiles, have now added another interesting chapter to the discussion.

It was a game of strategy and tactics deftly conceived and intelligently played, and was throughout a credit equally to the victor and the vanquished. It was an interesting contest, this object lesson on the science and art of naval warfare, though the pity of it all is that the material resources of the attack were so unworthy of the intelligence forced to use them.

On the one hand was a modern cruiser, defended, to a great degree, by means improvised from equipments designed for far different purposes; on the other was a little squadron of steam launches and pulling cutters, whale-boats and gigs, which were slow in speed, noisy in action, hampered by adverse tides and strong breezes, and so weak in defense that they were compelled to attack with the same offensive powers that Cushing, years ago, employed to destroy the *Albemarle*.

Broadly generalized, it was not so much one of those lessons which teach what attack and defense are as a proof of the possibilities inherent in a cruiser of modern design to utilize for her safety the appliances which have been more or less niggardly furnished her.

From the very beginning it was apparent to every sea-officer that the defense must be successful, though this in no way lessened the ability, energy and zeal shown by Captain Bunce of the *Atlanta* and his officers and crew. The lesson was a useful one to many who assisted the most important, perhaps, of all those practical experiments where, through a realization of the difficulties, our officers are being enabled to determine how much behind the age the navy has lagged in the keen race, not for supremacy but for equality with the great marine Powers.

The problem offered for solution was this, and it is an old one measured by the progress of naval science: An enemy's vessel is supposed to be anchored in a closed harbor, with no means of defense except such as are offered by the equipment of the ship; seaward there is a blockade, against which there is faint hope of escape by sudden dash, while landward an enemy's occupation of the strategic points offers no chance as assistance. These known quantities are complicated by the imminent danger of assault from torpedo-boats, from the possible presence of submarine mines and the certainty that any victory is but a temporary one.

Of course this problem has been attacked before—notably by the French and English in their manœuvres of the past two years; but with them the conditions were different, since the attack was supposed to be equal to the defense.

Torpedo enthusiasts, even on the face of latter-day results, are not yet satisfied that Gabriel Charmer was not right when he declared that "a squadron attacked by night torpedo-boats is a squadron lost."

Admiral Luce, in pursuance of the plan he has formulated for the drills of the North Atlantic squadron, took measures for making this attack as nearly practical as possible. The general theme was submitted to the 21 officers now in attendance at the War College, with a request that they should prescribe such rules as seemed best fitted to the circumstances. These officers in turn appointed a sub-committee, and, after careful examination and discussion, the following regulations were adopted:

THE REGULATIONS OF THE FIGHT.

1. To judge of the events connected with this attack several umpires will be stationed on board the *Atlanta*, and one umpire will be appointed to each torpedo-boat and each guard-boat.

2. Umpires are to consider themselves as such, not only for their own special posts, but for any operations of attack or defense which may come under their observation.

3. Any torpedo-boat shall be judged out of action:

(*a*) When under the fire of heavy guns a sufficient time to receive three rounds therefrom—say one minute.

(*b*) Or is under fire from rapid-fire guns a sufficient time to receive fifteen rounds therefrom—say three-quarters of a minute.

(*c*) Or is under Gatling-gun fire within 500 yards for one and a half minutes.

(*d*) Or is under a small-arm fire (of not less than ten pieces) within 500 yards, for one and a half minutes.

(*e*) Or is under an effective fire during 15 seconds while within the beams of the search light.

(*f*) Or receives water from the ship's hose during one-quarter of a minute.

(*g*) Or shall be within the effective range of a defense torpedo or mine at the time of the explosion of the same by the defense.

4. Any torpedo-boat succeeding in attaching an explosive charge to any part of the defense will make her claim by making her number three times by blasts from her whistle and shall be free to retire.

5. Any torpedo-boat which, without being discovered or ruled out, shall approach the *Atlanta* to within 20 ft., shall be considered as having successfully torpedoed her and will make her claim by firing a green "Very's signal light" into the air and shall be free to retire.

6. Guard-boats which shall fail to discover the approach of a torpedo-boat until the same is within 20 ft. from them shall be considered as destroyed.

7. When a torpedo-boat is put out of action from the *Atlanta*, the fact will be signified to it by hailing it or by "Very's signal light" discharged in the direction of the boat if not within hail. The boat judged out of action and notified of the fact shall immediately acknowledge it by reporting her number if within hail; otherwise by making her number once by whistle.

8. The decision of an umpire shall be final.

9. If the *Atlanta* is torpedoed once she shall be considered as disabled, and if torpedoed twice as destroyed.

10. The termination of the attack will be signified by the recall sounded by bugle from the *Atlanta*.

11. These rules shall, after approval by the committee on the same, be immediately communicated to all parties concerned therein.

This programme was submitted to Captain Bunce of the *Atlanta*, representing the defense, and to Commander C. M. Chester of the *Galena*, to whom was intrusted the attack, with instructions to adopt such measures as would enable them, while complying with their letter and spirit, to utilize the appliances at their disposal for the special duties each had to perform. Both officers were left untrammelled by any official interference, and in the end Commander Chester adopted the following plan for his offensive operations:

THE ORDERS FOR THE ATTACK.

The torpedo attack will take place on the night to be designated.

The attacking force will consist of six steam launches and four pulling boats (gigs or other light boats), all to be under the command of Commander C. M. Chester.

The steam launches will be numbered successively from one to six inclusive, and the pulling torpedo-boats as per following list annexed.

All torpedo-boats will be armed with one light torpedo spar, fitted with a primer that will explode if closing nearer than 20 ft. to the attack. They will also carry two or three Very's (red) signals to be fired only when assistance is needed. The eight pulling or decoy boats will be armed with hand torpedoes, to be attached to the obstruction around the *Atlanta*.

The object desired is to have the defense contemplating an attack only by steam launches, and then suddenly find itself required to throw the electric light over a large number of boats, with the possible result of permitting one or more of them to take advantage of the dark rays and make a successful attack.

Just as soon as it gets dark—before 7.30 P. M., if possible—the four boats of the *Richmond* will proceed to the west end of Rose Island and endeavor to keep in ambush until the commencement of the attack. The four boats of the *Dolphin* will proceed at the same time around the north end of Goat Island and lie in ambush near the south end of that island. The boats from the *Galena* will, by a détour, endeavor to reach the cover of the wharf at Fort Adams. The *Ossipee's* boats will remain under cover of that ship.

At 8.15 P. M., the boats from the several divisions will deploy to a distance of about 200 yards, the steam launches leading, followed by the decoy boats, and the pulling torpedo-boats last. The advance will commence at the same time or

immediately after the deploy, when each boat will endeavor to reach the *Atlanta* as soon as possible. Of course, it should be the aim to take advantage of the dark sector of the *Atlanta's* electric light to secure a score within 30 ft. of that ship. The decoy boats will strive to reach the obstructions around the vessels should their consorts be counted out.

The *Ossipee's* division will delay its advance slightly to allow the other divisions to get their distance.

When the recall is sounded the steam launches will assemble alongside the *Atlanta* and all other boats will return to their respective ships without further instructions, the pulling torpedo-boats delaying long enough to land their umpires on board the *Atlanta*.

Should the umpire (one in each boat) declare a steamer within the proper distance to score a point, she will make her number three times and withdraw. If discovered, and it is so indicated by proper signal from the *Atlanta*, she will make her number once and withdraw. Short toots corresponding to the numbers given in this order will designate the steamers. The other torpedo-boats will, in like manner, give their number and the name of the ship to which they belong once or three times and withdraw. Watches will be set at sundown, which is 5h. 12m.

The boats will have their numbers tacked on the bow.

Organization—No. 1, steam launch *Vixen*, Commander Chester; No. 2, steam launch *Richmond*, Lieutenant Nazro; No. 3, steam launch *Ossipee*, Lieutenant Delano; No. 4, steam launch *Galena*, Lieutenant Sharrer; No. 5, steam launch *Dolphin* (No. 1), Lieutenant Marshall; No. 6, steam launch *Dolphin* (No. 2), Lieutenant Cutler.

No. 1, *Richmond's* cutter (torpedo-boat), Lieutenant Kilburn. No. 2, *Richmond's* whale-boat, Cadet McMiller. No. 3, *Richmond's* gig, Cadet Russell.

No. 1, *Ossipee's* cutter (torpedo-boat), Ensign Snowden. No. 2, *Ossipee's* whale-boat, Ensign Brainerd. No. 3. *Ossipee's* gig, Naval Cadet Brown.

No. 1, *Galena's* cutter (torpedo-boat), Ensign Gibson. No. 2, *Galena's* whale-boat, Naval Cadet Young. No. 3, *Galena's* gig, Naval Cadet Bristol.

No. 1. *Dolphin's* cutter (torpedo-boat). No. 2, *Dolphin's* whale-boat.

Preparations were commenced upon the *Atlanta* at 3 P. M. on Monday, and by sundown the trim-looking cruiser was in a fighting form which recalled forcibly the appearance of the more splendid English war machines, as they steamed into position for the bombardment of Alexandria. Everything aloft except the lower yards was sent down, the rigging and gear being neatly and securely lashed, and the lower mast heads, especially at nightfall, looking not unlike vigilant sentries, silhouetted against the sky and eager for any enemy that might appear.

A stout 5-in. steel hawser was passed around the ship just high enough above water to prevent a hostile boat going over or under it; this was guyed clear of the ship by the unrigged spars, the topsail yards being used to starboard and the topmasts to port. These were supported by pennant tackles from the lower yardarms while the bights of the hawser were secured to their outer ends by stout lashings.

Forward, two spare booms were rigged 24 ft. outward, and to these were attached a secondary steel hawser that encircled the ship from stem to stern. Upon the main hawser, at distances 30 ft. apart, were suspended 20 torpedoes, each controlled electrically, and so arranged as to fire on a closed circuit by contact, and with such a radius of fire that any boat striking the hawser within a space of 15 ft. was exposed to the destructive action of one or two torpedoes.

Towing astern was a whale-boat which supported a steam pump hose in such a position that a vigorous stream of supposititious hot water could be directed against any approaching boat, while forward, another arrangement of the same hose enabled this method of defense to be usefully employed.

Fifty yards astern of the ship, a hawser, carrying spare booms and buoyed by empty water casks, was anchored, and from this was suspended ropes which were intended to entangle the screws of the attacking steam launches.

Two search-lights, which subsequently did most effective service, were mounted, one aft on the starboard and one forward on the port side, and their 24-in. lenses were so arranged that the 16,000 candle power developed was directed without dispersion, in a cylindrical tube of light, close to the water and with a range of over 1,500 yards.

The broadside defense being nearly perfect, the shifting 6-in. guns were trained so as to fire fore and aft, thus enabling five guns to be brought on these bearings, while there was always a beam fire of at least eight pieces.

It will be seen from this that the defense consisted of two principal lines—an outer one, composed of search-lights, battery and guard boats, and an inner one of hawsers, spars, booms and torpedoes.

Contrary to general expectation, but as it proved with great good judgment, Captain Bunce moved his vessel and took up a new anchorage further seaward in the outer harbor.

Up to this time the squadron, consisting of the flagship *Richmond*, the sloops of war *Atlanta*, *Galena* and *Ossipee* and the dispatch boat *Dolphin*, had been disposed in a column two cables apart heading N. N. E. and S. S. W., the flagship furthest to the northward, and the *Atlanta* at the southerly end of the line.

In this position certain effective defenses of the *Atlanta* were neutralized, while her rear was exposed to attack in the most vital part, but in the new place chosen to receive the enemy, a large section of offence was cut off by the interposition of Rose Island, which bore about northeast, distant about 1,000 yards.

The day had opened with a strong gale from the southward and moderately rough water, but as the morning grew the wind and sea subsided, though the sky was still overcast and lowering. As the sun went down the wind freshened, and the ebb tide was running so strongly as to promise that the attacking flotilla would have a severe task in taking up favorable positions.

At 7 o'clock, the *Atlanta's* crew went quietly to quarters, all lights save the electric battle lanterns were extinguished, and with unremitting search the long cylindrical beams of light swept the encircling waters and the land. Soon after 7, the umpire selected for the ship reported on board, and then from every coign of vantage eager eyes peered into the gloom for the first approach of the enemy.

It was a weird and striking scene—the dismantled ship, the silence broken only now and then by quiet words of command, the stalwart bluejackets each in his place, the long line of bright lights showing at the rim of the town and fading into the slight rise where Miantinomi Hill crowns the city, the muffled pulsations of the steam pumps below, and outward the subdued rush of the busy guardboat crossing and recrossing within the boom on the line of attack astern. Everywhere there was an alertness, a zeal, which spoke volumes of praise for what these trained seamen would do in time of actual war.

There was a quick cry of recognition about 7.30 o'clock as the starboard search light caught in its mesh of illumination the first of the approaching boats, and then when the agreed time had elapsed there was the snappy report of a fiery signal, and then an answering light from the disabled boat—disabled by force of agreement. From this time forward it was one succession of discoveries—boats to starboard, boats to port, boats astern and boats ahead. Nothing escaped those pitiless lights, and with the colored flaring of the bursting signals there came at intervals, when the discovery was made close aboard, the sharp rattle of the Gatling-gun cranks, the snap of the sharpshooters' rifles on the quarter deck and superstructure and the brief decision of the umpire:

"Steam launch *Vixen* disabled."

"*Ossipee's* whaleboat out of action."

"*Galena's* gig"—and very close did this one and the *Dolphin's* steam launch come—"*Galena's* gig and *Dolphin's* launch disposed of."

There is not much more to tell, except to say that of all the flotilla not one was enabled to get within any destructive distance of the *Atlanta*—indeed, so complete was the work of defense that the much prized hose with its supposititious aqueduct of boiling water was never called into play. The recall was sounded at 9 o'clock; the steam launches came alongside; the pulling boats disembarked their umpires, and from each and every officer came the story:

"It was of no use; we were discovered before we got within fair fighting distance, and by the rules we are fairly whipped."

Aluminum Bronze for Heavy Guns.

MR. ALFRED H. COWLES read a paper on the subject expressed in the above title before the United States Naval Institute at the meeting held in Annapolis, October 27. Advance copies were issued and sent to a large number of metallurgists and ordnance officers, who were invited to discuss the question.

A brief abstract of the claims made in Mr. Cowles's long and interesting paper is as follows:

The question for discussion embodied in the paper is: "How near can aluminum bronze approach the requirements of a perfect gun-metal?"

Assuming that the gun-carriage takes up the recoil, a perfect gun might be described as a gun of minimum weight and simplest construction, which shall be able to resist a maximum internal pressure without permanent distortion, and thereby be enabled to throw a projectile with maximum energy. It is impossible to attain perfection. For safety, the metal in a gun should have the property of stretching much beyond its elasticity; thereby danger of violent explosion is greatly diminished. In order to make the nearest approach to the above, the metal employed should have as high tensile strength, and elastic limit, and as great elastic extension as possible. Its ductility should be great, if it can be obtained without sacrificing its other properties. Hardness to resist erosion is not a principal requirement, as it is now a common practice to protect the inner wall of a gun with a steel tube which can easily be removed. Further, and of greatest importance, the metal should be of such a nature as to enable us to make the whole gun in one solid piece, and yet attain, as near as possible, a finished gun, in which the initial tensions of the metal shall vary from the bore outwards to correspond exactly with the variation in strain thrown upon its different parts at the moment of explosion.

The Rodman cast-iron guns approach these requirements, inasmuch as they are solid throughout; and it is to be noted that, although steel in the modern built-up steel guns has three times the tensile strength of cast-iron, yet the powder pressures that are obtained in service show that not more than 25 per cent. increase in efficiency is gained in the built-up steel gun over the rifled cast-iron guns, and the latter are more enduring.

Recent experiments have developed the fact that there are numerous alloys of aluminum with copper, with copper and nickel, and with copper and zinc, castings of which equal steel forgings in their physical properties. With these alloys at command, which can be cast more readily than cast-iron, there are two well-tried methods of fabrication that can be employed to give solid guns of much greater destructive power than can possibly be obtained with steel.

First the Rodman: Were this employed, aluminum bronze of more than three times the tensile strength of cast-iron could be used. The temperature at which this grade of bronze solidifies is 1,600° Fahrenheit, as compared to 2,700°, the melting temperature of cast-iron. With this low temperature, we could heat the outside of the mold as hot as the molten metal, and thereby cause all cooling to take place entirely from within. This would be the ideal perfection of the Rodman method of casting guns.

Second, and probably the best method to follow, is the Dean process. In this case the gun would be cast in an iron mold of a grade of aluminum bronze, castings of which have a higher tensile strength and ductility than the finest quality of mild-steel forgings. The solid gun would then be bored, and conical chilled-steel mandrils of gradually increasing diameter successively driven through the bore. The metal around the bore, by this process of cold stretching, would, thereby, be given a greater strength and hardness, a higher elastic limit and greater elastic extension. These properties would gradually vary till the outer circumference of the gun is reached, where the metal is left in its normal condition of great toughness. It would be impossible to burst such a gun with four times the powder pressure now used in the built-up steel gun. The wall would be solid. There would be no danger of crystallization. The finished gun would have the color and the luster of gold. It would not be corroded by salt water. Plants for producing aluminum bronze and casting such guns would not require more than one-third as great an outlay in capital as it is proposed to invest in plants for the construction of built-up steel guns, and not one-quarter the time would be necessary to build either the aluminum plant or guns. The mineral resources of our country are capable of supplying inexhaustible quantities of the raw material necessary for the production of aluminum alloys. Were our Government at the present time enabled to make the great advance proposed above in the art of gun fabrication, we would render valueless against us the present armaments of Europe. Cast guns can be made from aluminum bronze, at its present cheapened price, at 20 per cent. less cost than forged guns of steel; and further, 60 per cent. of this cost is capital stored away in the metal of the gun, which can be remelted and used over an indefinite number of times. This is not the case with steel guns, which, when once destroyed, are a total loss, 98 per cent. of their cost being in their fabrication.

A YEAR'S WORK OF THE SIGNAL SERVICE.

GENERAL A. W. GREELY, Chief Signal Officer of the United States Army, has submitted to the Secretary of War his annual report upon the operations of the Signal Corps. The report begins by inviting attention to the condition of the military signaling system, and says that for several years there was not even a division of military signaling in the office of the Chief Signal Officer, and it is only within the past 18 months that the slight and perfunctory attention paid to this branch of the service has been rectified.

Despite the advisability of experiments and improvements for such active service, the Chief Signal Officer regrets to say that the field-telegraph train of the Signal Corps is practically the same now as that used nearly a quarter of a century since.

The system of visual signaling also remains the same, with reference to flags and torches, as in war time. Efforts are being made, with gradual success, to simplify the models of the old and cumbersome flag kits and to replace the torches by a more satisfactory and economical element.

It is intended to make careful experiments during the coming year with homing pigeons, and the Chief Signal Officer has directed that experiments be made from Key West toward Cuba, with the expectation, based upon the opinion of experts, that, by training these birds in flights from seaward, a United States squadron in the vicinity of Havana might be enabled to communicate rapidly and certainly with the naval station at Key West. If such flight be possible from Cuba, it could be eventually extended to the Windward Islands, even to Nassau.

Reference is made to the good results attending the use of expert signalmen in General Miles's campaign, and the case is used as an illustration of the necessity for special training and drill to procure officers and men whose services can be relied upon in the field. It is said to be evident from the record of this and past years that, instead of the Army being properly and efficiently drilled in military signaling, there is not an average officer to a regiment who is competent to transmit signals—by sun, flag and torch—day and night, except those who have passed through a regular course of instruction in direct connection with this office.

Touching weather forecasts, General Greely says he has been strongly urged to furnish special predictions for cities, towns and corporations—a work which, so far, this office is unable to satisfactorily undertake, owing to the limited time which elapses between the receipt of the

telegraphic reports and the hour at which the predictions must be issued to the general public. He hopes, however, during the ensuing year, to make arrangements which, in addition to providing the Northwest with more accurate warnings of coming cold waves, will also furnish the great centers of population with special predictions.

The increase in the length of hours in the tri-daily indications has, it is said, naturally resulted in a reduced percentage of verification, the diminution amounting to 7 per cent.; but it is believed that this may be compensated for by increased skill and practice. On this point the report says:

It has been a subject of complaint that the indications of this service have not improved to the extent expected, and since the statement has been officially put forth that the indications are made by the same officers who have made them for years, it is presumed that the public labors under the same misapprehension.

Such is not the fact, as within the past three or four years the relief of the old officers detailed from the line of the Army has been forced upon the Chief Signal Officer by Legislative action. In consequence, it followed that the young officers of the Signal Corps, who have only within the past year or two received any extended instruction in meteorology, have been assigned to this important duty. Within the past year, three officers have necessarily been assigned to indications work who never before have performed duty of this character.

It consequently followed that, through restrictive legislation, the Chief Signal Officer finds himself compelled to permit the new officers to serve their apprenticeship in predicting at the expense of the whole country. It has occurred, as might be expected, that the novices in the work at times made errors that subjected the service to criticism, which, well merited in such cases, cannot be considered valid criticism of the methods followed by the service.

The general percentage of successful indications during the year has been: For weather, 74.5; wind, 69.1; temperature, 74.4; a general average of 73.9. This result is not satisfactory to the Chief Signal Officer, but the reasons for it have been stated as above.

Reference is made to the discontinuance of the West Indian service, and its renewal is suggested, in order that notice may be given of approaching hurricanes.

During the current year there have been 1,510 storm signals of all kinds ordered, of which 1,034, or 68.5 per cent. have been verified. This percentage is the lowest for years, and the causes therefor are those set forth in treating the subject of indications of this service.

The Bureau has in view the early display of signals which will not only indicate whether the storm is to be light or severe, but also show whether winds are to come from a special quarter, and—a matter at times of great importance—whether the storm center is approaching or has passed the station.

In order to meet the needs of the Northwest and to comply with the earnest applications from citizens and corporate bodies of great vested values the Chief Signal Officer has under consideration the plan of stationing an indication officer at St. Paul, Minn. This arrangement would enable that officer to receive his reports upon an average of an hour earlier than in Washington, and would further enable him to send out warnings of cold waves in that section from two to five hours earlier than is now done. Of the cold-wave signals sent out, 78.06 per cent. were verified.

The Chief Signal Officer has faithfully carried out the arrangements authorized by the Secretary of War, which assured Professor Mascart, Director of the Central Meteorological Office of Paris, that France and England should have the hearty co-operation of the United States Signal Service in the transmission of such weather despatches as would benefit the meteorological service of those countries. This information has so far been collected and telegraphed at the expense of the English and French governments, but, in view of the hearty and generous co-operations which these nations have always extended in any scientific matters of interest or value to the United States, it is recommended that the attention of Congress be called to the propriety of making an appropriation for this service, which would scarcely amount to $1,000 a year.

Touching the river and flood reports, General Greely says it seems to him that such a system of river and rainfall stations might be established as would enable a practised indication officer to predict, with considerable certainty, the extent and continuance of any great flood, many days in advance, so that timely warnings would afford ample opportunity for such precautions as would mitigate the severity of such disasters.

The report mentions that the general bibliography of meteorology is nearly completed, the subject classification and author indexing having been finished during the year, in addition to the revision of the material on hand and the collection of the new titles.

The recommendation for the purchase of a suitable building in Washington for the use of the bureau is renewed, and it is shown that the result would be economy in the saving of rental.

ESTIMATES.

The estimates of the service for the fiscal year ending June 30, 1889, are $80,155 less than those for the current fiscal year. The re-arrangement of the work of the service, the discontinuance of certain sections of telegraph lines, an improved weather code and other changes in the direction of simplicity and economy have enabled this considerable reduction. The decreases will, it is said, in no way affect the efficiency of the present service.

General Greely concludes his report with a plea for a regular organization of the corps, pointing out the faults of the existing service and suggesting an organization comprising, besides the Chief Signal Officer, one major, six captains, six first lieutenants, two professors and two junior professors. A detail of six lieutenants selected from officers who have served two years in the line of the Army would insure material from which the corps could be properly recruited by future competitive examinations. The proposed organization would leave the regular corps with fourteen officers, against sixteen at present, and at practically the same expense. No officer should be promoted in this corps without examination under rules similar to those in force in the Medical and Ordnance Services. Regarding the enlisted men in Washington, he believes that the interests of the government, both in efficiency and economy, would best be subserved by the discharge from the Army of the purely clerical force in the City of Washington, and the organization of a civilian clerical force, such as now obtains in the offices of the Adjutant General, Surgeon General, Quartermaster General and elsewhere.

Steel Lace.

THE Pittsburgh *Chronicle-Telegraph* says: "The question of making laces of iron and steel for ladies' and children's wear is again being discussed in art, mill and fashion circles. At the Centennial, in 1876, a piece of steel rolled by a Pittsburgh mill was on exhibition which was so thin and light that it weighed much less than a book leaf, and could be blown from the hand easier than a piece of paper of the same size. The iron leaf was rolled on a train of rolls upon which heavy tank and boiler iron is now rolled.

"Experts say that curtains and other fine laces can be made of soft malleable iron, and in every way be used with greater satisfaction than cotton laces. The sheets will necessarily have to be rolled down to an exceedingly low gauge and then pressed into any desirable pattern and shape. There will be no trouble in furnishing iron laces for ladies' and children's wear, with their names and other ornamentations in filigree design. An introduction of steel lace would establish in Pittsburgh an industry that would give work to, at least, 3,000 men and consume annually not less than 76,000 tons of steel, which is now a drug in the market at less than 2 cents a pound. Steel lace, unlike cotton, can be made light or heavy without affecting the grade, color or brightness. We may yet see fashionable ladies wearing steel shawls and trimmings for their hats and dresses."

MESSRS. BOWLER & CO., Cleveland, O., manufacturers of car-wheels, have just completed a new foundry. The building is a substantial structure, 140 ft. wide and 200 ft. long, containing 16 cranes and molding floors, and each floor holding 20 wheels.

CATECHISM OF THE LOCOMOTIVE.

(*Revised and enlarged.*)

By M. N. Forney.

CHAPTER I.

FORCE AND MOTION.

Question 1. *How do we get our first notion of the nature or of the effect of force?*

Answer. It is suggested to us by the so-called muscular sense; that is, we have a peculiar feeling of pressure when we try to move any object or piece of matter.

Question 2. *What is "force?"*

Answer. We know nothing about the absolute nature of force. All that we know is what we can learn through the senses of its effects. It has been defined as "that which *affects* the motion of matter;" and again as "any action between two bodies which changes, or tends to change, their relative condition as to rest or motion." In the plainer words of a distinguished author* "the word force is obviously to be applied to any pull, push, pressure, tension, attraction or repulsion, etc., whether applied by a stick or a string, a chain or a girder, or by means of an invisible medium" such as the attraction of gravitation or electricity."

Question 3. *How is the motion of one body in relation to others produced?*

Answer. It is produced by the exertion on it of force.

Question 4. *Are bodies ever made to move in any other way excepting by the action of some force or forces on them?*

Answer. No. Part of what is called the first law of motion is that "*a body at rest remains at rest until some force acts upon it to set it in motion.*"

Question 5. *What is the other portion of the first law of motion?"*

Answer. "*That a body in motion continues with its motion unchanged, either in direction or velocity, until acted upon by some external force.*" Thus a top can be made to spin in the open air for a minute or more, but in a vacuum it will spin a much longer time, because there it has not the resistance of the atmosphere to overcome. If it be accurately balanced and revolves on a small steel point which bears on a glass plate, it can be made to spin in a vacuum for an hour or longer, because there the resistance, or force, which is opposed to its revolution is reduced to the lowest possible amount. Nevertheless, this force, however small, will check the speed of the revolutions of the top, and finally it will cease to spin altogether. As there is always some force which resists motion, there is a corresponding tendency which causes bodies about us, as we know them, to come to a state of rest.

Question 6. *When is motion said to be uniform?*

Answer. When a body passes over equal spaces in equal periods of time. Thus, the motion of the minute hand of a clock is uniform, because it passes over equal spaces on the clock face in each minute or hour. A railroad train is said to have a uniform velocity when it runs successive miles in the same number of minutes or seconds.

Question 7. *What is meant by accelerated and retarded motion?*

Answer. Motion is *accelerated* when the spaces passed over in equal periods of time become greater and greater, and motion is *retarded* when these spaces become smaller and smaller. Thus, if a railroad train should run one mile in five minutes, the next one in four, and the following ones in three and two minutes each, its motion would be said to be *accelerated.* A stone falling from any height is another example of accelerated motion. On the other hand, a railroad train, when it is being stopped, and a stone thrown upward are examples of retarded motion.

Question 8. *What is meant by uniformly accelerated or uniformly retarded motion?*

Answer. Motion is said to be uniformly accelerated or retarded when the increase or diminution of velocity in each interval of time is the same. Thus, if a railroad train should have a velocity of two-tenths of a mile at the end of the first minute, three tenths at the end of the second, four-tenths at the end of the third and five-tenths at the end of the fourth, its moti n would be said to be uniformly accelerated. A falling body is another example. Its velocity is 32.2 feet per second at the end of the first second, 64.4 at the end of the second, 96.6 at the end of the third, etc. In the case of the railroad train, the velocity is increased one-tenth of a mile for each minute, and that of the falling body is increased 32.2 feet for each second.

Question 9. *How is the velocity of a moving body increased or diminished?*

Answer. By the action of force on it. If this force is exerted in the direction of the movement of the body, its velocity will be increased so long as the force, or the *motive power* as many call it, is greater than the resistance opposed to it. Whenever the motive power equals the resistance, then the moving body will have a uniform speed; and when the resistance becomes greater than the moving form, the velocity will be retarded.

Question 10. *How is this illustrated in a railroad train and a locomotive?*

Answer. When the locomotive starts, the speed of the train is increased, until its resistance is equal to the force or power exerted by the engine. If the train reaches a grade, and its resistance is consequently increased, its speed will be retarded. On a level, the speed will also be retarded if steam is shut off, either partially or wholly, so as to diminish the force or power which the engine exerts.

Question 11. *What relation is there between the force exerted on a moving object and its velocity?*

Answer. With any object of a given weight, the greater the force exerted the quicker will the speed be increased or diminished. Every boy has learned this in drawing a wagon or sled or in trying to stop one in motion.

Question 12. *Do we know how much the velocity of a moving body will be increased or diminished by a known force?*

Answer. Yes, this has been ascertained by the effect of the attraction of gravitation, which causes all objects to fall toward the center of the earth if their movement is not resisted by some greater force.

Question 13. *What is the rate of acceleration of falling bodies?*

Answer. It has been found by the most exact experiments, that at the surface of the earth all bodies falling in a vacuum, where the air offers no resistance, acquire a velocity of 32.2 feet per second at the end of the first second, 64.4 feet at the end of the second second and 96.6 feet at the end of the third, and so on with an increase of 32.2 feet for each successive second.

Question 14. *Can this increase in motion be represented in any way by a drawing?*

Answer. Yes, we can draw a diagram which will show to the eye the rate at which a body falls. To do this let us suppose that a stone is allowed to fall from o, fig. 1, and that the distance o 1 is drawn to any convenient scale to represent the distance, 16.1 feet, that it will fall in the first second; 1 2 the distance, 48.3 feet, that it will fall the second second; and 2 3, 3 4, 4 5 and 5 6 the distances it will fall in successive seconds. If now from 1 a horizontal line, 1 1', be drawn whose length

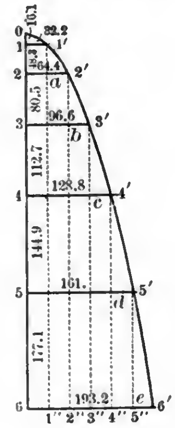


Fig. 1

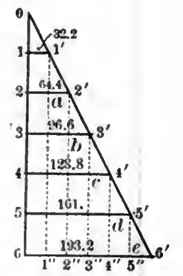


Fig. 2

represents 32.2 feet, the velocity the stone will acquire at the end of the first second, and 2 2', 3 3', etc., be drawn, each representing the velocity in feet per second that the stone has acquired at the end of the successive seconds, and a curve, o 1' 2' 3' 4' 5' 6', be drawn through the extremities of the horizontal lines, then the horizontal distance of the curve from any point in the vertical line *o 6* will represent the velocity of the stone at that point.

Question 15. *In what way may this diagram be modified?*

Answer. For some purposes, which will be explained in a future chapter, it is more convenient to make the spans o 1, 1 2, 2 3, etc., between the horizontal lines, which represent seconds, equal to each other as in fig. 2. The lines 1 1', 2 2',

* P. G. Tait. "Recent Advances in Physical Science," p. 35.

etc., can then be drawn as in the preceding diagram, and the line o 1' 2' 3', passing through their extremities, will then be a straight line if the fall of the stone is uniformly accelerated, as it would be if it fell in a vacuum.

QUESTION 16. *How is the law which governs the velocity of falling bodies still further illustrated by the diagrams?*

Answer. Before this question is answered it will again be explained, and should be clearly understood by the reader, that in fig. 1 the spaces between the horizontal lines represent the *distances* through which the stone falls in successive seconds, whereas, in fig. 2 the spaces represent the *periods of time* or *seconds* occupied by the fall.

In both figures, the lines 1 1' represent the velocity, 32.2 feet per second, that the stone has acquired at the end of the first second. If its fall was not still further accelerated than the dotted line, 1' 1" would represent its velocity. But in falling from 1 to 2 it again acquires an addition of 32.2 feet per second,—represented by the line *a 2'*—to its velocity, so that at the end of the second second it is 64.4 feet. By examining the diagram, it will be seen that during each second of the fall the velocity previously acquired by the stone is increased by the amounts represented by the lines *b 3'*, *c 4'*, *d 5'* and *e 6'*, each equal to 32.2 feet.

QUESTION 17. *How is the law which governs the distance through which a body will fall illustrated by the diagram?*

Answer. As shown in fig. 2 the stone starts from a state of rest at *o*, and at the end of the first second has acquired a velocity of 32.2 feet per second. Its average velocity during the first second is, therefore, one-half of 32.2 feet, so that it falls 16.1 feet in that time. As it has acquired a velocity of 32.2 feet at the end of the first second, it would fall that distance during the second second, but during that time it acquires an additional velocity of 32.2 feet which will cause its fall 16.1 feet further than it would if it was not accelerated during that period. The distance that it will fall in the second second is therefore $32.2 + \frac{32.2}{2} = 48.3$ feet. From the diagrams it will be seen that in each successive second the distance that the stone falls is 16.1 feet more than that through which it fell the preceding second.

QUESTION 18. *How can the velocity of a falling body be calculated?**

Answer. As shown by the diagrams the velocity which a stone acquires is equal to 32.2 feet per second at the end of the first second; at the end of the second second it is twice 32.2; at the end of the third second it is three times, and so on; so that if we *multiply 32.2 by the number of seconds that the body has fallen will give its velocity.*

QUESTION 19. *How is the distance through which a body will fall in a given time calculated?*

Answer. Multiply the square of the number of seconds, that the body has fallen, by 16.1. The product will be the distance fallen.

QUESTION 20. *Do all bodies fall at the same velocity?*

Answer. In a vacuum, where the atmosphere offers no resistance, they all fall at the same velocity. A feather will fall as fast as a piece of lead, and a cannon ball, weighing one pound, will fall as quickly as one weighing a hundred.

QUESTION 21. *What relation is there between the weight and the motion of a body?*

Answer. The heavier a body is, the greater will be the force required to move it and to accelerate or retard its motion. This we all learn by ordinary experience, as in drawing a wagon or moving a piece of furniture. We are apt to attribute it to the fact that the friction of heavy objects when rolling or sliding is greater than light ones, which is part of the reason why more force is required to move them; but if we suspend two cannon balls, one weighing one pound and the other a hundred pounds, by long cords, so that they can swing freely like a pendulum, with little or no friction, we will find that it takes a much greater force to move the heavy ball than is needed to move the light one the same distance in the same time. In this case there is hardly any resistance excepting *inertia*, which opposes the swinging of the balls.

QUESTION 22. *What is meant by inertia?*

Answer. It is defined as "that property of matter by which it tends when at rest to remain so, and when in motion to continue in motion."

QUESTION 23. *What relation is there between the weight and the inertia of a body?*

Answer. They are proportional to each other. That is, a body weighing a hundred pounds has twice as much inertia as one weighing fifty. It will be found that the heavy suspended cannon ball will take a hundred times as much force to cause it to swing a given distance in a given time as is needed for the light one. It is assumed that they are suspended by very long cords so that the arc or path in which they swing does not differ appreciably from a straight line.

QUESTION 24. *If this is the case why is it that a heavy object will fall as quickly as a light one?*

Answer. It is because its *weight*, which is the force that causes the heavy body to fall, is proportional to its inertia That is, each pound of inertia—if we may so express it—has one pound of weight or force to impel the body downward.

QUESTION 25. *Would a force acting upward, horizontally or in any other direction have the same effect?*

Answer. Yes, if it acted against a body which could move freely and without any other resistance excepting that of its own inertia.

QUESTION 26. *How can this be more clearly illustrated and explained?*

Answer. To make this clear, we will again suppose that we have a cannon-ball, *B*, fig. 3, suspended by a very long string so that it can move freely, and the arc in which it will be required to swing will not differ appreciably from a straight line. We will also suppose that we have a long cylinder, *C*, with a piston, *P*, and rod, *R*, fitted in it so that they can move freely in the cylinder—the rod *R* being attached to, or bearing against, the cannon-ball *B*. If, now, we were to admit steam or compressed air into the cylinder by the pipe *S*, of such a pressure that the force exerted on the cannon-ball is equal to its weight,

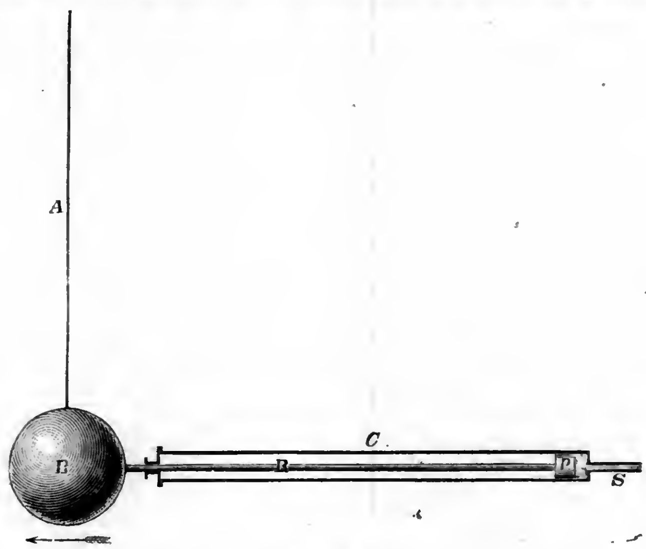
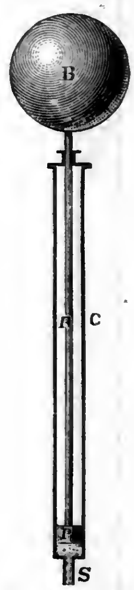


Fig. 3.

then, assuming that there is no friction of the piston, the ball would be moved in the direction in which the force or pressure on it is exerted, and in a given time it would acquire the same velocity that it would if it were allowed to fall freely. In the

Fig. 4.



arc case, the pressure in the piston acting in a horizontal direction is the accelerating force, and in the other, the accelerating force is the attraction of gravitation or weight of the cannon-ball which acts downward. If these forces are equal

* This rule is correct only for bodies falling in a vacuum, but is approximately correct for heavy bodies falling in the atmosphere.

to each other the velocity and acceleration of the suspended ball in a horizontal direction will be the same as if it was allowed to fall vertically an equal distance.

If we had a vertical cylinder as shown in fig. 4 with a ball, *B*, piston *P* and rod *R*, then if the pressure in the piston was equal to its own weight and that of the rod and ball, the two forces, that is, the pressure under the piston acting upward and the attraction of gravitation acting downward, would just balance each other, and there would be no motion. If, however, the pressure against the piston was double that of the weight on it, then there would be an upward force equal to twice the weight of the parts, which would be resisted by their inertia alone. Consequently, under these conditions the cannon-ball would fall upward—if such an expression may be used—at the same velocity that it would fall downward by its own weight.

QUESTION 27. *If the force acting on a moving body is increased or diminished what effect does it have on the velocity.*

Answer. The velocity is in exact proportion to the force acting on it. If you double the force, you double the velocity. Thus, if the cylinder shown in fig. 4 was turned upside down, and a pressure was then produced on top of the piston equal to the weight attached to it, then there would be two forces acting downward on the cannon-ball—its own weight and that due to the pressure on the piston. If the two are equal then the cannon ball would fall at double the velocity that it would if acted upon by gravitation alone. This principle is applied to steam-hammers, which are so arranged that when a light blow is required the hammer-head is allowed to fall by its own weight alone, but when a harder blow is needed steam is admitted above the piston to force it and the hammer-head down faster that it would fall by its own weight.

CHAPTER II.

THE FORCES OF AIR AND STEAM.

QUESTION 28. *What is meant by the pressure of the air?*

Answer. It is the force exerted by the weight of the air on every point with which it is in contact. The globe of the earth is surrounded by a layer of air about 50 miles thick, and, like every other substance, the air possesses weight, and hence presses upon every object with which it is in contact.

QUESTION 29. *How can it be shown that air possesses weight?*

Answer. By weighing a flask when it is filled with air, and again when the air is exhausted from it. In the latter condition the weight of the flask will be found to be sensibly less than it was when full of air, showing that the air which the flask contained when it was first weighed increased its weight.

QUESTION 30. *Why do we not feel this pressure on our bodies?*

Answer. Because the air surrounds us on all sides, and presses just as much in one direction as it does in another, so that the pressures in different directions just balance each other, or are *in equilibrium;* but if the air presses on one side only of an object as it does when you suck the air from a tube closed at one end and you cover the open end with your tongue, the air then presses your tongue against the tube, and the one appears to adhere to the other; or if the air be sucked out of a

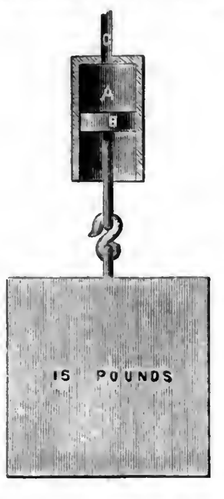


Fig. 5.

tube, one end of which is inserted in a liquid, the latter will be forced up the tube. A piece of thick leather under ordinary conditions will not adhere to anything, but if it be thoroughly wet and pressed hard against the surface of a smooth stone, so as to force out the air from under it, the stone, as nearly all school boys know, can be lifted up if a string is attached to the leather. These phenomena are due to the pressure of the atmosphere; in the first case on one side of the person's tongue, pressing it against the mouth of the tube; in the second to the weight of the air pressing on the surface of the liquid, forcing it into the vacuum in the tube, and in the last, to the same pressure on the top of the leather, causing it to adhere to the stone.

QUESTION 31. *What is the amount of the pressure of the atmosphere, and how is it measured?*

Answer. It is usually measured by the pressure on one square inch of surface, which, at the earth's surface, is 15 pounds.* If, for example, we have a cylinder, *A*, fig. 5, with an air-tight piston, *B*, fitted to it whose area is just one square inch, if through the tube *C* we exhaust the air from the cylinder above the piston, the air will press against the under side of the piston so that, if no power is required to overcome its friction in the cylinder, the pressure of the air will raise a weight of 15 pounds. The pressure of the air varies, however, as you ascend or descend from the surface of the earth, because as you go up on a mountain or in a balloon the layer of air above you becomes thinner, and, therefore, its weight and consequent pressure are diminished; and as you descend, as in a deep mine, the layer is thicker, and its pressure consequently greater.

QUESTION 32. *What is steam?*

Answer. In the dictionary, steam is defined as "the elastic, aëriform fluid into which water is converted, when heated to the boiling point," or, in other words, steam is water changed by means of heat into a gas. It is the transparent fluid which escapes from the mouth of a tea-kettle when the water in it is boiling. The visible cloud which escapes from boiling water and is seen in the form of mist at the mouth of the exhaust-pipe of a steam engine is not true steam. It is rather small particles of water, into which the steam has condensed through contact with the cold air. True steam is invisible, as we may observe near the mouth of a kettle or the exhaust-pipe of an engine from which we know it is escaping. At every temperature there is formed from water, on its surface, vapor of which the clouds are formed at all seasons of the year. This change of water into vapor, or evaporation of water, takes place at low temperatures only on its surface, however. But if we heat water in a vessel to a temperature of 212 degrees Fahrenheit, then the inner particles of the mass of water (lying on the heating surface of the vessel) are changed into steam, and rise to the surface in bubbles, which is the phenomenon we call *boiling.*

QUESTION 33. *If water is heated in an open vessel, what occurs?*

Answer. It continues for some time to increase in temperature, and the evaporation becomes more and more rapid. At length bubbles of vapor break out and reach the surface, and the process of boiling or ebullition has begun. When this takes place, the temperature of the water ceases to rise, and it remains stationary until all the water has boiled away, the only difference being that if the supply of heat be very great the process is very rapid, and if the supply of heat be small the process is very slow. The point at which ebullition commences is called the *boiling point*

QUESTION 34. *On what does the boiling-point depend?*

Answer. Chiefly on the pressure on the surface of the water, but to some extent upon the purity of the water. Thus, boiling, which takes place at 212 degrees under the ordinary atmospheric pressure, in lighter air, as on high mountains, takes place at a much lower temperature than on lowlands, and so water boils in a glass tube from which the air has been exhausted by the warmth of the hand, that is, at 92 degrees.

QUESTION 35. *What is the pressure of steam which escapes from boiling water in an open vessel?*

Answer. It is exactly equal to the pressure of the atmosphere in which it is boiled. Ordinarily, this is 15 lbs., and the boiling-point 212 degrees; but if we go up on a mountain where the atmospheric pressure is only 10 lbs. per square inch, the water will then boil at a temperature of 193 3 degrees, and the steam which escapes will have the same pressure as the atmosphere, or 10 lbs. per square inch. On the other hand, if we could go down into a mine where the atmospheric pressure was 20 lbs. per square inch, the water would not boil until it was heated to 228 degrees, and the pressure of the escaping steam would then be 20 lbs. per square inch.

QUESTION 36. *If water is boiled in an enclosed vessel, like a covered tea-kettle or a steam-boiler, what occurs?*

Answer. The steam rises and fills the space above the water, and, if it cannot escape, increases in pressure. The temperature of both the water and the steam rises with the pressure, and will continue to do so as long as the heat is increased, or until the steam can escape, or the vessel is exploded. The boiling point also rises as the steam pressure increases.

*In common practice it is generally taken at 15 lbs. per square inch, but the average atmospheric pressure is, more accurately, 14.7 pounds

QUESTION 37. *How can this effect be illustrated?*

Answer. It can be shown if we take a glass tube *T*, fig. 7, closed at its lower end, and put a small quantity of water in it, and then force a cork, *C*, which fits the tube, or a wad of cotton saturated with tallow, down on top of the water, and then hold the lower end of the tube over a spirit lamp or gas flame, and

Fig. 7.

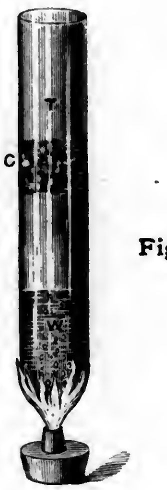


Fig. 8.

heat it slowly, so as not to crack the glass tube. Bubbles of steam will then form at the bottom of the water, as shown in fig. 8. These will rise to the top, and will soon force the cork or wad of cotton upward with more or less violence, in proportion to the tightness with which it fits the tube, and the rate at which the water is boiled.

QUESTION 38. *Is there any pressure which corresponds to the temperature of steam and water?*

Answer. Yes. There is a fixed pressure for every temperature, when steam is in contact with water, and its pressure cannot be increased or diminished without at the same time heating or cooling the water, and the higher the temperature of the water the greater will be the corresponding steam pressure. Thus water at 212 degrees produces steam with a pressure equal to that of the atmosphere; at 240 degrees, the steam will have a pressure of 25 lbs. per square inch, or 10 lbs. more than the atmospheric pressure; at 281 degrees, a pressure of 50 lbs.; and at 328 degrees, 100 lbs. As this relation of pressure to temperature is fixed, if we know the one we can tell the other. This is true, however, only where the steam is in contact with water, when it is called *saturated steam*. If it is separated from water, it may be heated to a higher temperature without increasing its pressure in the same proportion, and it is then called *superheated steam*.

QUESTION 39. *How is the pressure of steam measured?*

Answer. In the same way as that of the atmosphere—that is, by the force exerted on one square inch of surface. Thus, if steam is admitted into the cylinder *A*, fig. 9, under the piston *B*, whose area is equal to one square inch of surface—sup-

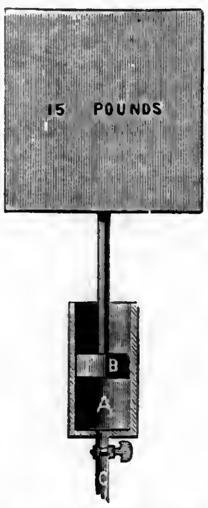


Fig. 9.

posing, as we did before, that no power is required to overcome its friction in the cylinder—then, if the pressure of the steam thus admitted below the piston would just balance the pressure of the atmosphere above it, the steam pressure would be equal to 15 lbs. If, besides overcoming the pressure of the atmosphere, the steam below the piston would raise a weight, *W*, of 15 lbs., then its pressure per square inch would in reality be equal to 30 lbs. per square inch. If the pressure of the atmosphere is *included* or *added to* that of steam *above* it, it is called its *absolute pressure*. In ordinary high-pressure steam engines, however, the steam must always overcome the pressure of the atmosphere, and therefore the only part of the pressure which is effective is that above, or by which it exceeds, the atmospheric pressure. This is therefore called the *effective* or *working pressure*. For example, although the steam admitted under the piston in fig. 9 has an absolute pressure of 30 lbs. per square inch, yet it will only raise a weight of 15 lbs., because it must first overcome the pressure of the air on the other side of the piston. The pressure of the steam used in most stationary and in locomotive engines is, therefore, measured by its pressure above the atmosphere. That is, if steam introduced under the piston in fig. 9 will raise a weight of only 15 lbs., we say it has a pressure of 15 lbs. per square inch; if it will raise 50 lbs., its pressure is said to be 50 lbs. per square inch, and so on. The pressure of the atmosphere is disregarded, and all steam-gauges used on locomotives are graduated in that way. In speaking of steam pressure in future, therefore, unless otherwise specified, we shall mean *effective* or *working* and not *absolute* pressure.

QUESTION 40. *What is meant by the expansion of steam?*

Answer. In all gases a repulsion is exerted between the various particles, so that any gas, however small in quantity, will always fill the vessel in which it is held. Steam possesses this same property, and, if placed in any vessel, the particles in endeavoring to separate from each other will exert a force on all its sides. This force we call the steam pressure. To illustrate this we will suppose that the cylinder *A* in fig. 9 is half filled with steam of 30 lbs. pressure. If, now, the supply of steam is shut off, the steam in the cylinder will expand so as to push the piston upward, but with a somewhat diminishing force, the nature of which will be explained hereafter.

QUESTION 41. *What is meant by the volume of steam?*

Answer. It means the space which the steam occupies.

QUESTION 42. *What is the proportion which exists between the volume and the absolute pressure of steam?*

Answer. If the temperatures remain the same they are INVERSELY PROPORTIONAL TO EACH OTHER; that is, the one increases in the same proportion as the other diminishes. If we admit steam of 30 lbs. pressure per square inch into the cylinder *A*, fig. 9, and then cut off the supply by closing the cock *C* and allow the steam in the cylinder to expand to double its volume by pushing the piston to the end of the cylinder, the steam pressure will then be only 15 lbs.; if it should expand to three times its volume its pressure would be only one-third, or 10 lbs. per square inch. This method for calculating the pressure of steam after it has expanded is correct only for the *absolute* and not for the *effective* pressures of steam. In order to ascertain the effective pressures of steam after expansion, it is only necessary to make the calculation with the absolute pressure and deduct the atmospheric pressure from the result. If, after being thus expanded, the piston be pushed down again so as to compress the steam into its original space, its pressure will again be 30 lbs., providing no heat has been lost in any way.

QUESTION 43. *With a cylinder of any given stroke* how can we determine approximately the pressure of the steam after expansion for any given point of cut-off?* †

Answer. BY MULTIPLYING THE ABSOLUTE PRESSURE PER SQUARE INCH OF THE STEAM IN THE CYLINDER BEFORE IT IS CUT OFF, BY THE DISTANCE FROM THE BEGINNING OF THE STROKE AT WHICH IT IS CUT OFF, AND DIVIDING THE PRODUCT BY THE WHOLE LENGTH OF THE STROKE. Thus, if we have a cylinder whose piston has a stroke of 24 inches, if we cut off the steam at 8 inches, and have an ABSOLUTE pressure of 90 lbs. in the cylinder, the calculation is as follows:

$$\frac{90 \times 8}{24} = 30 \text{ lbs. final pressure.}$$

If we cut off at 10, 12 and 15 inches, the final pressure would be 37½, 45 and 56¼ lbs., respectively. To get the effective pressure deduct the atmospheric pressure from this result.

QUESTION 44. *What is the proportion between the volume of steam and that of the water from which it is formed?*

Answer. At the pressure of the atmosphere (15 lbs.) each cubic inch of water will make 1,610 cubic inches of steam. At

*The *stroke* of a piston is the distance it moves in the cylinder, and in ordinary engines is always twice the length of the crank, measured from center to center of the shaft and crank-pin.

†The steam is said to be *cut off* when the steam-port or opening by which steam is admitted to the cylinder is closed by the valve.

double that pressure, or 30 lbs. absolute pressure, it will make a little more than half as much, or 838 cubic inches; at four times, or 60 lbs. absolute pressure, 437 cubic inches, or a little more than a fourth as much as at the pressure of the atmosphere.

QUESTION 45. *Why is it that the quantity of steam at high pressures is somewhat greater than in inverse proportion to the pressure?*

Answer. Because the boiling-point of water, as has already been explained, is higher as the pressure increases, and therefore the temperature of the steam produced at such pressure is also higher than at lower pressures; and, as all gases are expanded by heat, therefore the volume of steam at the higher pressures is somewhat greater than in inverse proportion to its pressure, on account of being somewhat expanded by its high temperature. To make this plain, if we take a cubic inch of water and convert it into steam of atmospheric pressure, its volume will be 1,610 times that of the water and its temperature 212 degrees.* If we convert this quantity of water into steam with a pressure double that of the atmosphere, the volume of the steam will be 838 times that of the water and its temperature will be 250.4 degrees. If the volume of the steam were exactly *inversely proportional* to the pressure, the cubic inch of water at double the atmospheric pressure would make only 805 cubic inches of steam; but, as the boiling-point at that pressure is 38.4 degrees higher, the steam is expanded 33 cubic inches by the increase of its heat due to the higher boiling-point.

QUESTION 46. *What is meant by the condensation of steam?*

Answer. It is the reconversion of steam into water by cooling it, or depriving it of part of its heat. It has been shown that the temperature of water must be raised to a certain point to generate steam of a given pressure. If the process is reversed, and we deprive the steam of a part of its heat, some of the steam is then at once reconverted into water, or *condensed*, and the pressure of that which remains will be reduced just in proportion as the heat is lost. When the temperature gets below 212 degrees under atmospheric pressure, all the steam will be condensed. As the useful work which steam can do in an engine is due to its pressure, which, in turn, depends on its temperature, any loss of heat will diminish its effective power. For this reason, all waste of heat from a steam engine should, as far as possible, be prevented.

QUESTION 47. *How is the heat of the steam wasted or lost in an ordinary steam engine?*

Answer. It is wasted in three ways: first, by *conduction*; second, by *convection*; and third, by *radiation*.

QUESTION 48. *What is meant by these three terms?*

Answer. (1.) By *conduction* is meant that phenomenon which is manifested when we put one end of a metal bar, two or three feet long, into the fire and heat it. The heat is then gradually conveyed from one particle of the metal to that next to it until finally the end of the bar farthest from the fire may become so hot that it cannot be touched. The heat is then said to be *conducted* through the bar. In the same way the metal of the boiler, pipes, cylinders and other parts of the engine becomes heated on one side, and the heat is thus conveyed to the outside of these parts.

(2.) The air with which they are surrounded then becomes heated, and, being then lighter than the cold air, it rises and is again replaced with air which is not heated. In this way the heat is *conveyed* away by the air, and this phenomenon is therefore called *convection*,

(3.) If an iron plate be placed in front of an ordinary grate fire, three or four feet from it and exposed to the rays of heat from the fire, it will soon become so hot that you cannot bear your hand on it. If you place your hand between the iron plate and the fire you will find that only the side of your hand which is exposed to the fire will become hot; showing that the air between the plate and the fire is not nearly so hot as the plate soon becomes, and therefore that the heat is not conveyed to the plate by the air between it and the fire, but by the rays from the fire. This phenomenon is called *radiation*. The same thing occurs from any hot body, as, for example, a coil of steam pipe for heating a room, a steam boiler, or cylinder of an engine.

QUESTION 49. *Is there any difference in the conducting and radiating power of different substances?*

Answer. Yes, very great. The difference in the *conductiug* power of wood and iron is shown if we place one end of a bar of each in the fire. The wood will be consumed without warming the bar more than a few inches from the fire, whereas the iron will soon become hot two or three feet from the fire. Owing to the difference in the conducting power of cotton and wool, we wear cotton clothing in summer and woolen in winter, because cotton allows the heat of the body to be conducted away from it, whereas woolen cloth prevents to a great degree this loss of heat. For the same reason, the venders of roasted chestnuts on our streets wrap them in a piece of blanket to keep them hot, that is, to keep the heat in; and in summer we wrap ice in the same way to keep it cold, that is, keep the warmth of the air out. The wool, being a very bad conductor of heat, simply prevents the heat from being transferred from the inside to the outside, and *vice versa*. It is for this reason that steam boilers, pipes and cylinders are nearly always covered with wood, and sometimes with felt.

The difference in the *radiating* power of various substances can be shown if we take a large thermometer and heat it up to the temperature of boiling water. If this thermometer is hung up in a room having the temperature of melting ice, it will lose in two ways—first, by heating the air which surrounds it, that is, by *convection*, and also by *radiation*. In order to confine ourselves to the latter process, we will suppose that the chamber is a vacuum. If we first cover the bulb of the thermometer with a thin coating of polished silver, and then ascertain how much heat it radiates in a minute, and then coat it with lamp-black and repeat the same experiment—that is to say, allow the thermometer at the boiling-point to cool for one minute in a vacuum chamber at the freezing-point—it will be found that the thermometer loses much more in a minute when coated with lamp-black than it did when coated with silver, showing that much more heat is radiated from a surface covered with lamp-black than from polished silver. Generally, it may be stated that polished metals radiate much less heat than surfaces which are not polished.* For this reason, as well of for ornament, locomotive and other boilers and cylinders are usually covered with Russia iron or polished brass.

CHAPTER III.

ON WORK, ENERGY AND THE MECHANICAL EQUIVALENT OF HEAT.

QUESTION 50. *For what purpose are all steam engines used?*

Answer. They are used to produce *motion*, which is opposed by some *resistance*. Thus, if an engine is employed to raise grain from a railroad car to the top of a warehouse, it must produce motion, which is resisted by the weight of the grain; if it is used to saw wood, it must give motion to the saw, which is resisted by the fibers of the wood; a locomotive engine must produce motion of a train of cars, which is resisted by the air, the friction of the journals and the rolling of the wheels on the track; if the locomotive is employed on a grade or incline, besides the frictional resistance referred to, it must overcome that due to its own weight and that of the train, which is gradually lifted as it ascends the incline. In producing motion opposed by some resistance an engine is said to be doing "*work*."

QUESTION 51. *Can this work be accurately measured?*

Answer. Yes; but in order to measure anything we must first establish some accurate standard or unit of measurement. Thus, we say a bar of iron is so many inches long, or a road is so many miles long. In like manner we speak of so many seconds, or minutes, or hours, or days, or years, when we speak of time. So it is necessary, in order to estimate or measure "*work*" in a strictly scientific manner, for us to fix upon some accurate standard or unit. In this country and in Great Britian the unit agreed upon for this purpose is the amount of power required to raise ONE POUND ONE FOOT, and is called a *foot-pound*. If we raise one pound two feet we do two foot-pounds of work; if three feet, three foot-pounds, and so on. Again, if we raise a weight of two pounds one foot high, we likewise do two foot-pounds of work; or if we raise it two feet high, we do four foot-pounds, and so on. In order to determine the amount of work done, we must MULTIPLY THE MOTION PRODUCED (*in feet*) BY THE RESISTANCE (*in pounds*), AND THE RESULT WILL BE THE WORK DONE IN FOOT-POUNDS.

QUESTION 52. *How many foot-pounds of work are performed in a pile-driving machine in raising a weight of 1,200 lbs. 24 feet?*

Answer. 1,200 × 24=28,800 foot-pounds.

QUESTION 53. *When this weight is raised, is the force which was exerted in raising it annihilated or lost?*

Answer. No; because the weight has the capacity of doing

* More accurately, 213.1 degrees, if we call the atmospheric pressure lbs.

* The account of the above experiment is copied from Balfour Stewart's very excellent little book, "Lessons in Elementary Physics," of which, and the same author's "Elementary Treatise on Heat," the writer has made frequent use.

an equal amount of work when it falls, from the momentum* it acquires in falling. This *power of doing work* which it acquires in falling is called *energy*. Now, although the weight has no motion-producing power when it is raised to the top of the machine, yet, obviously, such action is then *possible* which, when it rested on the earth, was not possible. It has no energy as it hangs there dead and motionless; but energy is possible to it, and we might fairly use the term *possible energy* to express this power of motion which the weight possesses,† and which is therefore called *potential energy*. As soon as the weight is allowed to fall it acquires a greater velocity the farther it falls, and its potential energy thus becomes and is called *actual energy*.

QUESTION 54. *How do we explain such phenomena as the heating of a car-axle while turning under a car, the heating of brake-blocks when the brakes are applied to car-wheels, the heating of an iron rod by hammering, and of a turning tool when cutting a piece of metal?*

Answer. All of these phenomena are due to the fact that the *actual energy* of motion is converted into heat, as has been repeatedly proved by many able and ingenious investigators and experiments.

QUESTION 55. *When the weight of the pile-driver falls, is its energy also converted into heat?*

Answer. A part is expended in compressing the material into which the pile is driven and in overcoming the friction of the earth against the pile, each of which efforts develops heat, and another portion is converted into heat by the impact or blow of the falling weight on the head of the pile.

QUESTION 56. *Is all energy convertible into heat and heat into energy?*

Answer. Yes. Science has demonstrated very clearly that they are mutually convertible.

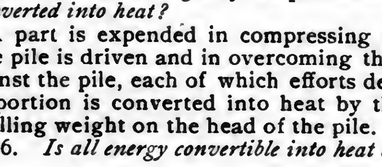
QUESTION 57. *Has it been ascertained how much heat is equivalent to one foot-pound of work?*

Answer. Yes. It has been found, from the most carefully-made experiments that the amount of heat which is required to raise the temperature of one pound of liquid water by one degree of Fahrenheit ‡ is equivalent to 772 foot-pounds of work. It must be remembered that this is the theoretical equivalent of heat, and that only a very small proportion of this amount of work is ever realized from the heat developed by the combustion of fuel.

QUESTION 58. *If, then, heat is convertible into work and work into heat, can the transmutation of the heat of the steam in the cylinder of an engine into work and the reverse process be explained?*

Answer. Take a cylinder, fig. 10, and, in order to make the conditions of the experiment as simple as possible, imagine it to be placed in a vacuum. Now let saturated steam be admitted under the piston so as to fill the cylinder half full at an

Fig. 10.



absolute pressure of 100 lbs. If we will allow this steam to expand to double its volume and raise the piston *without doing any work*, and then repeat the experiment with a load of 50 pounds on the piston, whose area is one square inch, it will be found that the temperature of the steam is sensibly less, after lifting the weight, than in the previous experiment, in which it expanded without doing work, showing that part of the heat was abstracted from the steam by doing work, or, in other words, was converted into work. If then, after the steam has expanded and lifted the weight, we press the piston down so that the steam under the piston is compressed to its original volume, we shall find that its temperature is the same as before, as the work done in compressing it is converted into heat. In these experiments it is assumed that there is no friction of the piston, nor loss of heat from radiation or conduction. The same phenomena can be observed in machines used for compressing air. In these, the air is heated to so high a temperature when it is compressed that it is sometimes necessary to cool the cylinders by circulating a current of cold water around them.

QUESTION 59. *What practical relation is there between the convertibility of heat into work and the conducting and radiating properties of different substances explained in answer to Question 49?*

Answer. The fact that heat is only another form of energy, or "the power of doing work," indicates that its loss by conduction or radiation lessens that power just as much as or more than the loss or waste of coal would, and therefore every effort should be made to protect the different parts of engines from loss of heat by covering them with substances which conduct or radiate very little heat. Care should also be taken to exclude cold air from circulating in contact with these parts, and excepting for supporting combustion, the nature of which will be explained hereafter, it should be excluded from the heating surface of boilers.

QUESTION 60. *What is meant by the term* LATENT HEAT OF EVAPORATION?

Answer. By *latent heat* is meant that heat which *apparently* disappears when water or other liquids are vaporized. Thus, it is found that if any quantity of water is converted into steam at any pressure, it is necessary not only to heat the water to a temperature equivalent to that of the steam, or to the boiling-point, but after the water has reached that temperature an additional amount of heat must be added in order to keep up the process of boiling. Notwithstanding this addition of heat to the water, the temperature of the steam produced will not be higher than that of the boiling water, thus showing that a considerable quantity of heat is absorbed, the only effect of which is to change the water into a gas or steam. This apparent disappearance of heat can be shown if we take a pound of boiling water whose temperature is 212 degrees and mix it with a pound of ice-cold water at 32 degrees temperature. The result will be a mixture of two pounds of water of a mean temperature of 122 degrees. If now we convert a pound of water into steam at atmospheric pressure, the steam will heat 6.37 lbs. of ice-cold water up to 122 degrees, showing that a pound of steam at atmospheric pressure contains over six times as much heat as a pound of water of the same temperature as indicated by a thermometer. A similar apparent disappearance of heat occurs when other liquids are evaporated, and when ice or any other solid is converted into a liquid.

QUESTION 61. *What is the explanation of these phenomena?*

Answer. The exact reasons which will explain them fully are probably not yet clearly understood, but it is at least extremely probable that when any substance is changed from a solid to a liquid, or from a liquid to a gaseous condition, "a large portion of the heat is spent *in doing work* against the force of cohesion."* The particles of solid bodies, as we know, are so united that it requires more or less force, according to the nature of the substance, to tear them apart. Now, we can conceive that the heat is changed into a form of energy, and in that condition resists this attraction of the particles to each other, and that being thus transformed it has lost the capacity of expanding the mercury in the thermometer. A similar effect takes place when a liquid is converted into a gas. In the former condition the particles move freely about each other and have little or no attraction for each other, but when it becomes a gas they have a *repulsion from* each other. The heat is thus converted into the energy of repulsion, and therefore is in reality no longer in the condition of heat and consequently does not affect the thermometer. We can illustrate this by supposing that, by using steam, heat is converted into work by raising the weight, or drop as it is called, of a pile-driving machine. When the weight is raised to the top of the guides from which it falls, although, as already explained, the heat is converted into *potential energy*, yet if we attached a thermometer to the drop we would not find that it was any warmer than before the drop was raised. If it were possible to make an instrument sufficiently sensitive to indicate an instantaneous change of temperature in the weight while falling, we would not find any increase of its temperature at the instant it had acquired its greatest momentum and just before it struck the object under it, although its potential energy would at that instant be converted into *actual energy* of motion. If, however, the weight should strike an unyielding object, its actual energy would at once be reconverted into heat, which our thermometer would indicate. The phenomenon of what is called latent heat of evaporation seems to be very similar to that described—the heat when the water is changed from a liquid to a gaseous condition is transformed into energy, which, as already stated, has no effect upon the mercury of the thermometer.

* Momentum is not a very exact term, but is used here because it ordinarily conveys the idea we wish to express.

† Tyndall's "Heat Considered as a Mode of Motion."

‡ Thermometers are divided into different scales. The one called the Fahrenheit scale, after its originator, is the one ordinarily used in this country.

* Balfour Stewart on the Conservation of Energy.

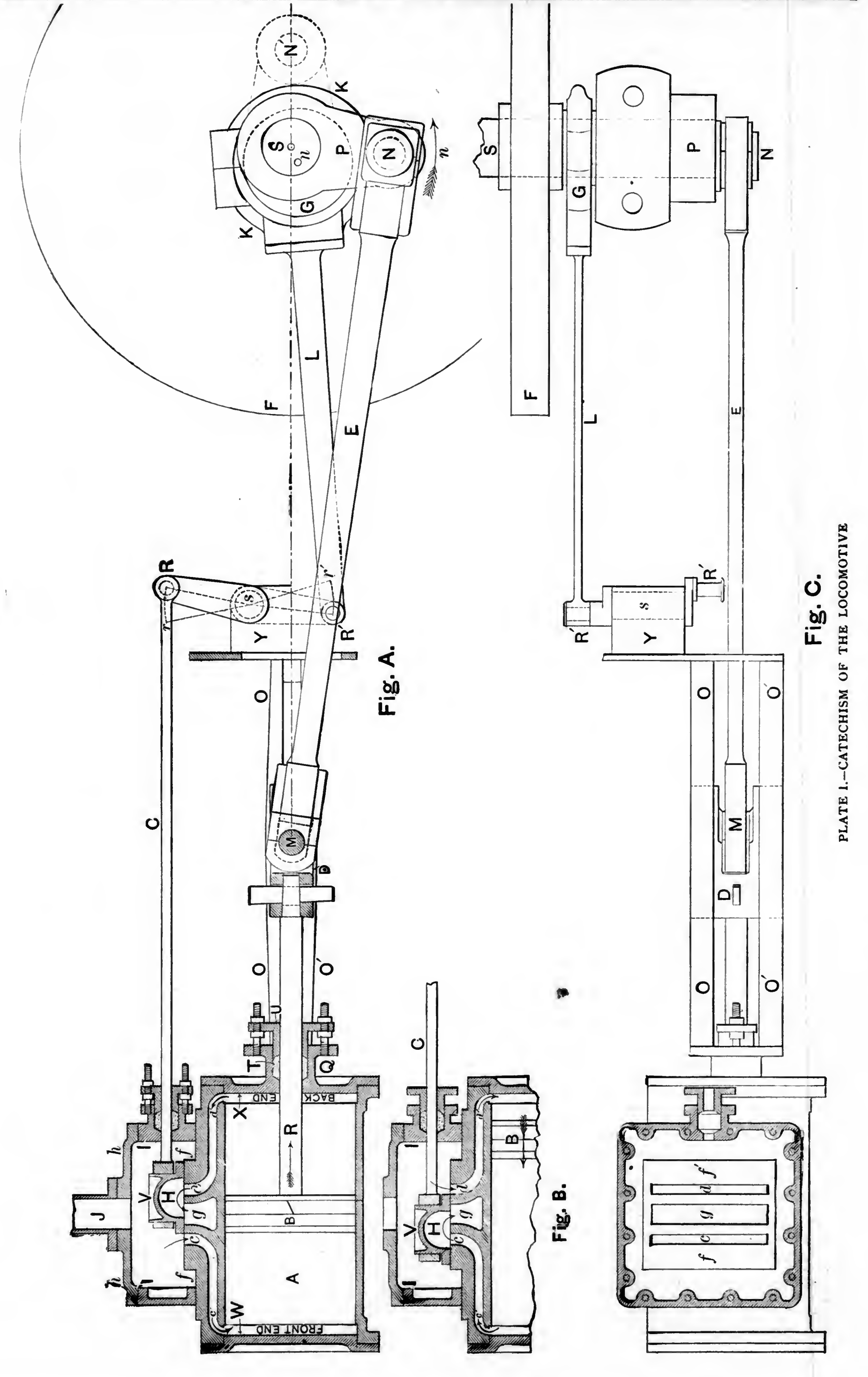


Fig. A.

Fig. B.

Fig. C.

PLATE I.—CATECHISM OF THE LOCOMOTIVE

QUESTION 62. *What is meant by the* TOTAL HEAT *of steam?*

Answer. The "total heat of steam" is a phrase used to denote the sum of the heat required to raise the temperature of water from some given point up to the boiling-point due to a given pressure, and of the heat which disappears in evaporating one pound of water under a given pressure (or *latent heat of evaporation*). Thus, the latent heat of one pound of steam at atmospheric pressure (14.7 lbs.) is 966.1 units; and 212 units of heat are necessary to raise water from zero to the boiling-point; therefore, the total heat counted from zero of steam of atmospheric pressure is 1,178.1 units. At 100 pounds absolute pressure the latent heat is 885.5 and the sensible heat 327.9 degrees; therefore the total heat measured from zero is 1,213.4 units.

CHAPTER IV.

THE STEAM ENGINE.

QUESTION 63. *What is the motive power employed in ordinary steam engines?*

Answer. The expansive force of steam.

QUESTION 64. *How is this expansive force of steam applied?*

Answer. It is applied by admitting it into a *cylinder* (*A*, fig. 11) in which a *piston*, *B*, is fitted so as to move air-tight from one end of the cylinder to the other. The steam, if admitted at *c*, will force the piston *B* to the opposite end* of the

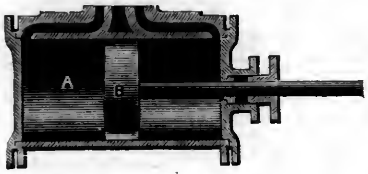


Fig. 11.

cylinder. When it has reached that end, if the steam is allowed to escape, and a fresh supply is admitted to the other end of the cylinder through the opening *D*, it will move the piston back again. In this way, by alternately admitting steam at one end and exhausting it from the other, the piston receives a *reciprocating motion*, which is communicated to the outside of the cylinder by a rod, *R*, which is called the *piston-rod*, which works air-tight through an opening in one of the *cylinder-covers*, or *cylinder-heads*, as they are usually called.

QUESTION 65. *How is this reciprocating motion of the piston converted into rotary motion?*

Answer. By connecting the end of the piston-rod *R* (fig. A Plate I) by another rod, *E*, called a *connecting-rod*, with a crank, *P*, which is attached to a revolving shaft, *S*. It is apparent that if the piston *B* is moved in the direction shown by the dart *R*. a rotary motion will be given to the crank in the direction of the dart *n*. When, however, the crank reaches the position shown by the dotted lines at *N'*, it is plain that a force applied to move the piston in either direction will no longer produce a rotary movement of the crank and shaft. The same thing will occur when the crank is in the opposite position. These two positions are called the *dead-points* of the crank.

QUESTION 66. *How is the crank of an ordinary steam engine carried past the dead points?*

Answer. A stationary engine usually has a large and heavy wheel, called a *fly-wheel*, *F F*, Plate I, which is attached to the shaft *S*. This wheel receives a sufficient amount of momentum from the crank, while the latter is moving from one dead-point to the other, to carry it past those points.

QUESTION 67. *How is the steam admitted to and exhausted from the cylinder?*

Answer. It is admitted through two channels, *cc'* and *dd"* called *steam-ways*, cast in the cylinder. These ways terminate in a smooth, flat surface, *ff'*, called the *valve-seat*. The openings of the steam-ports in the valve-seat are called *steam-ports*. Between them is another port or cavity, *g*, called the *exhaust-port*, which communicates with the open air. The form of these ports is long and narrow, as shown in fig. C, which represents a plan of the engine, or a view looking down from above it, with the top of the steam-chest and valve removed. Over these ports a valve, *V*, figs. A and B, called a *slide-valve*, which is usually made of cast-iron, with a cavity, *H*, on its under side—is fitted so that by moving it backward or forward it will alternately cover and uncover the two steam-ports. The valve and valve-seat are inclosed in a sort of box, *II*, made of cast-iron, called a *steam-chest*, into which steam is admitted from the boiler by a pipe, *J*. When the valve is in the position represented in fig. A, the front steam-port *c* is uncovered, and the steam is admitted to the front end of the cylinder, as indicated by the darts *c* and *c'*, and it thus forces the piston toward the back end, or in the direction of the dart *R*. If, when the piston reaches the back end, as shown in fig. B, the valve has been moved into the position shown, the back steam-port *d* will be uncovered, and steam will be admitted to the back end of the cylinder, as indicated by the darts *d* and *d'*. At the same time it will be observed that the front steam-port *c* and the exhaust-port *g* are both covered by the cavity *H* in the slide-valve, so that the steam which was admitted to the front end of the cylinder can now escape as indicated by the arrows *c'c*, through the steam-port into the exhaust-port *g*, and thus into the open air. By moving the valve alternately back and forth, steam is simultaneously admitted first to one end of the cylinder, and exhausted from the other, and *vice versa*.

Fig. 12

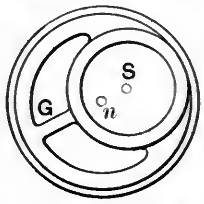


Fig. 13

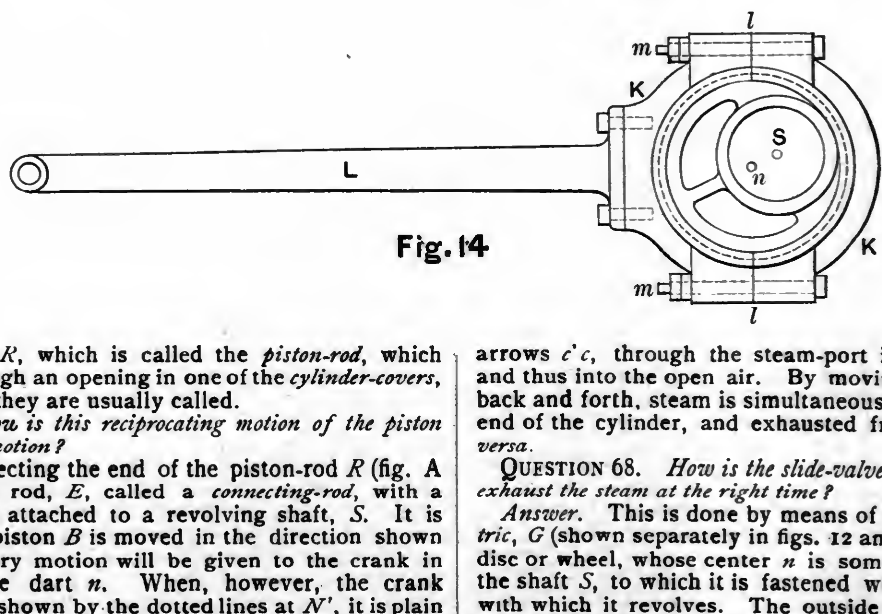


Fig. 14

QUESTION 68. *How is the slide-valve moved so as to admit and exhaust the steam at the right time?*

Answer. This is done by means of what is called an *eccentric*, *G* (shown separately in figs. 12 and 13), which is a circular disc or wheel, whose center *n* is some distance from that of the shaft *S*, to which it is fastened with keys or screws, and with which it revolves. The outside of the eccentric is embraced by a metal ring, *KK*, called an *eccentric-strap*, shown in fig. 14 and also in fig. A. This strap is made in two halves, which separate in the line *l l*. The two parts are fastened together by bolts, *m m*, which pass through lugs or projections cast on the straps, as shown. The outside, or the periphery,

*In all ordinary locomotives, the cylinders are so placed that the head *C* through which the piston-rod works is behind, and the other head *D* in front. The two ends of the cylinder are therefore designated the *front* and *back ends*, respectively.

of the eccentric, is accurately turned, and the inside of the strap is bored to fit it, so that the one can revolve inside of the other.

QUESTION 69. *How does an eccentric work?*

Answer. Its action is precisely like that of a crank, in fact it may be defined to be a crank with a crank-pin large enough to embrace the shaft.

QUESTION 70. *How is the motion of the eccentric imparted to the valve?*

Answer. A rod, *L*, called an *eccentric-rod*, is attached to the eccentric straps as shown in fig. 14. It is obvious from fig. *d*, that, if the eccentric revolves inside of the strap, it will impart a reciprocating motion to the rod *L*. The eccentric *G*, strap, *K*, and rod, *L*, are represented in fig. A. Before describing their operation, or rather their connection with the valve *V*, it is necessary to understand that in this country the slide-valves of locomotives are usually placed on top of the cylinders, in which position it is difficult to connect the eccentric-rod directly with the valve. For convenience, therefore, what is called a *rocker*, *R R'*, is placed between the cylinder and the main shaft of the engine. This rocker has two arms attached to a shaft, *s*, and the two arms have a vibratory motion about it, as indicated in the dotted lines *r R* and *R' r'*. The eccentric-rod *L* is attached by a pin, *R'*, to the lower arm of the rocker, and the valve is connected by the rod *C*, called the *valve-rod*, or *valve-stem*, to a pin, *R*, on the upper end of the rocker. It is obvious that, as the eccentric *G* revolves, a reciprocating or vibratory motion will be given to the rocker, which will be communicated to the valve by the valve-stem; and it is only necessary to fix the eccentric in the proper position on the shaft, in relation to the crank and piston, to give the valve the required motion for admitting and exhausting the steam to and from the cylinder at the right time.

QUESTION 71. *How can the action of the eccentric and the movement of the valve and piston during a complete revolution of the crank be shown?*

Answer. It can be illustrated and explained by the aid of a series of diagrams—figs. 15-29. In these diagrams most of the parts are represented by their center-lines and points only, so as to make them as simple as possible. The dimensions selected for these illustrations are, for the cylinder, 16 in. diameter and 24 in. stroke. The steam-ports are 1¼ in., the exhaust-port, 2½ in., and the metal or bars between them, which are called *bridges*, are 1⅛ in. wide. The eccentric produces a lateral movement of 4 in., which is called its *throw*.* In fig. 15, the piston is at the beginning of the backward stroke.

It will be seen that the valve *V* has then uncovered the first steam-port at *c*, and that steam can therefore enter the front end of the cylinder as indicated by the darts. At the same time, the exhaust-cavity *V* in the valve covers the exhaust-port *g* and the front steam-port *d* so that the steam in the back end of the cylinder can escape as shown by the arrows.

In fig. 16, the piston is represented as having moved 4 in. of its stroke; the valve has then opened both of the steam-ports wider. In fig. 17, the piston has moved 8 in. of its stroke, and the ports are now wide open, the front one to the steam and the back one to the exhaust. In fig. 18, the piston has moved 12 in., or is at half-stroke, and the valve has then moved to its extreme throw. In fig. 19, the piston has moved 16 in., and the valve has begun to return. In fig. 20, the piston has moved 20 in., and the valve has nearly closed the front port to the steam. In fig. 21, the forward stroke is completed, and the back steam-port is then slightly opened to admit steam into the back end of the cylinder for the return stroke. The front steam-port has also been made to communicate with the exhaust-port so that the steam in the front end of the cylinder will be exhausted before the piston begins to return.

Figs. 22 to 28 represent the positions of the piston and valve during the forward stroke, corresponding with those described for the backward stroke. The darts in the steam-ports in the figures represent the movement of the steam in each position of the piston and crank. Other darts show the direction in which the piston and crank are moving.

QUESTION 72. *How is the piston of a steam engine made to work steam-tight in the cylinder?*

Answer. The cylinder is first accurately bored out, and the piston has two metal rings around its periphery. Each of these rings is cut apart as shown in fig. A, plate I, so that they can be expanded by springs or other means to fit the cylinder. The open places are placed at different points on the circumference of the piston, so that the one opening is covered by the other ring, which prevents the steam from leaking through the openings.

QUESTION 73. *How is the piston-rod made to work steam-tight through the cylinder-head?*

Answer. By what is called a *stuffing-box*. This consists of a cylindrical chamber, *A A'*, figs. 30 and 31, which is made about 1½ inches larger in diameter than the piston-rod. This leaves a space ¾ of an inch wide all around the rod. This space is filled with hemp, *H*, or some other fibrous material, called *packing*, saturated with oil or melted tallow. This packing is compressed by a hollow cylinder, *C C*, called a *gland*, the inside of which fits the piston-rod P, and the outside the stuffing-box. This gland is forced into the stuffing-box by nuts *t t'* which are screwed down on a flange, *u*, *u'*, attached to the gland. The packing is thus compressed in the stuffing-box and forced against the piston-rod, which is made smooth and perfectly round and straight, and against the side of the stuffing-box, so that no steam can escape around the piston-rod. A brass ring or "*bushing*," *B*, is often put into the cylinder-head, and in the gland where it touches the piston-rod, because brass will bear the friction of the rod better than cast-iron, and, when it is worn out, it can be removed, and a new one substituted in its place. Packing made of metal is now often used instead of fibrous material. The construction of various kinds of metal packing will be described in a future chapter.

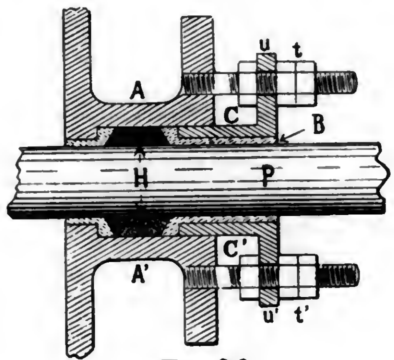


Fig. 30.

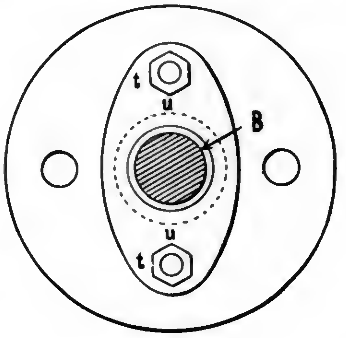


Fig. 31.

QUESTION 74. *How must the piston and piston-rod move in order to keep steam-tight?*

Answer. The center line of the piston and piston-rod must always be coincident with the axis or center line of the cylinder.

QUESTION 75. *How is the movement of the piston-rod affected by the connecting-rod?*

Answer. Excepting when the crank is at one of the dead-points, the center line of the connecting-rod is inclined to that of the piston-rod and axis of cylinder. Consequently, at all other points of the revolution, the connecting-rod has a tendency to either pull or push the end of the piston-rod downward, when the crank is turning in the direction that the hands of a watch or clock turn. If the crank turns the opposite way, as a locomotive wheel revolves when it is running ahead, the connecting-rod presses the end of the piston-rod upward.

QUESTION 76. *How is this action of the connecting-rod resisted?*

*There is some ambiguity in the use of the term *throw*. In Webster's dictionary it is defined as "the extreme movement of a slide-valve, also of a crank or eccentric, measured on a straight line passing through the center of motion." The definition of mechanical terms, in the edition of the dictionary quoted from, were prepared by the late Alexander L. Holley, so that no more eminent authority could be quoted for the usage of the term with this meaning. Nevertheless, the word *throw* is sometimes used to designate the distance from the center of a shaft to the center of a crank-pin or eccentric, which, of course, would be only one-half the extreme movement of a valve or piston.

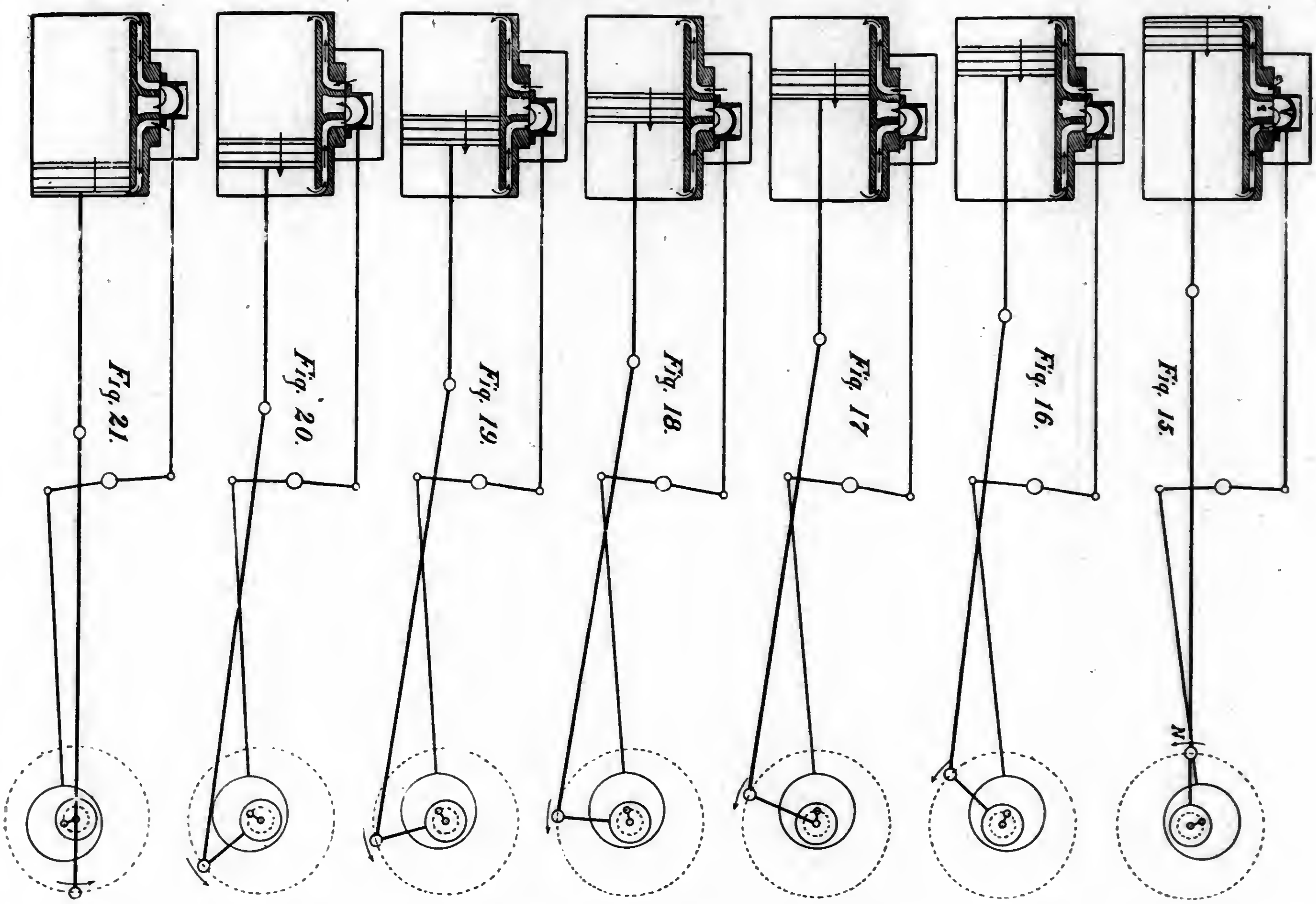


Fig. 21. Fig. 20. Fig. 19. Fig. 18. Fig. 17 Fig. 16. Fig. 15.

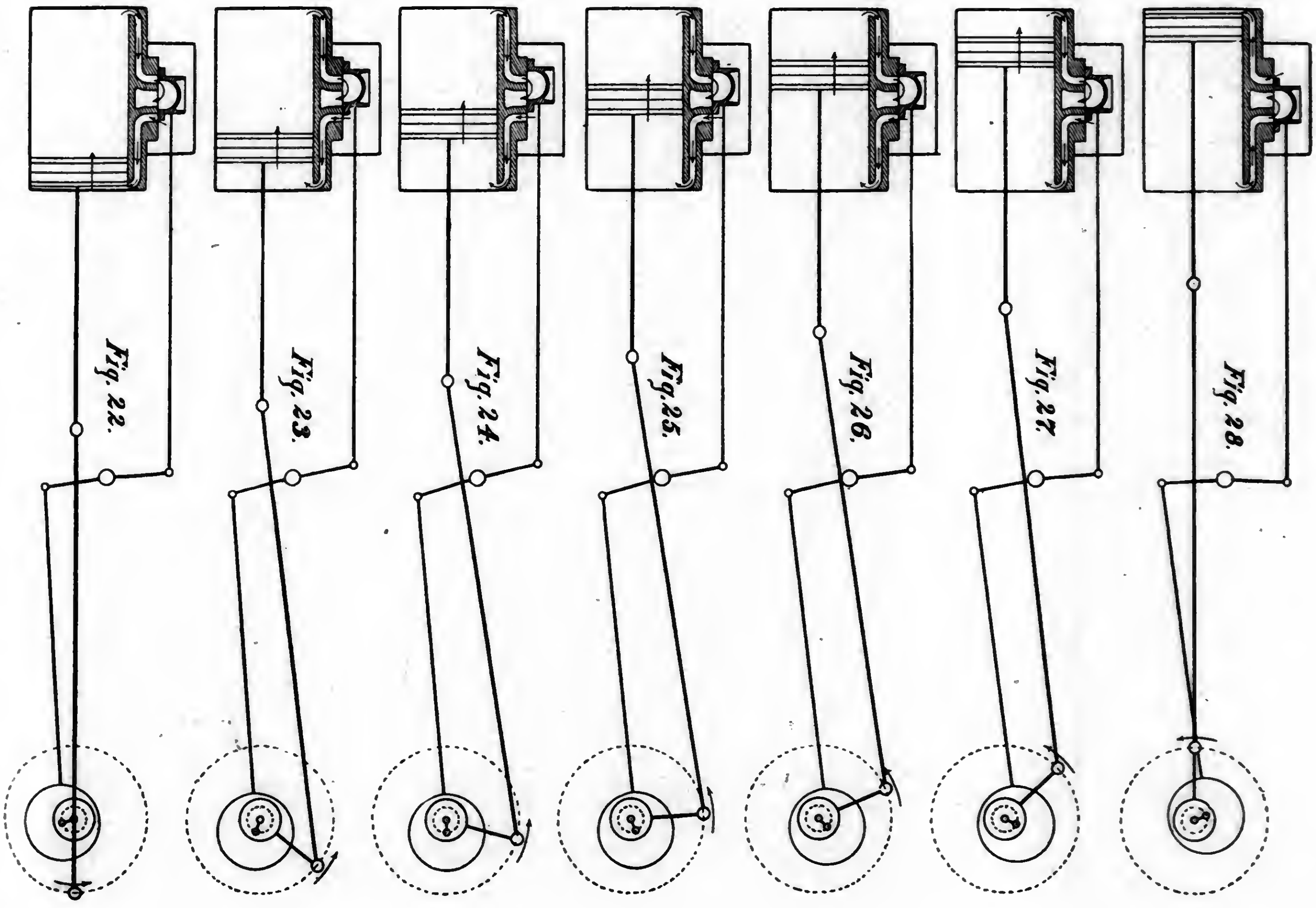


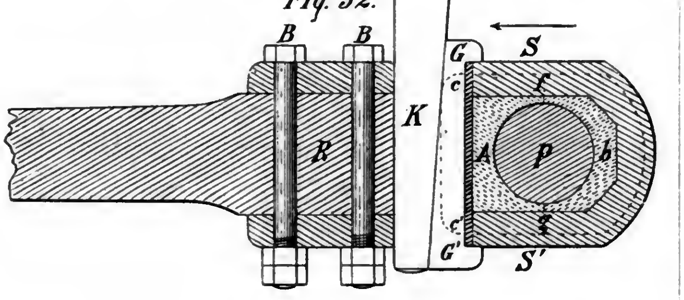
Fig. 22. Fig. 23. Fig. 24. Fig. 25. Fig. 26. Fig. 27. Fig. 28.

Answer. The back end of the piston-rod and the front, or *small end*, as it is called, of the connecting-rod are attached to what is called a cross-head, shown in figs. A and B, plate I. This moves between bars, *O O'*, called guide-bars, which are set so that the motion of the cross-head is coincident with, or parallel to, the axis or center line of the cylinder. As the end of the piston-rod is attached to the cross-head, they must both move in a path parallel to the faces of the guide-bars on which the cross-head slides. In this way, the pressure exerted by the connecting-rod bears on the guide-bars and is resisted by them.

QUESTION 77. *How is the connecting-rod connected to the crank-pin?*

Answer. By what is called a *stub-end* or *strap-head*, shown in fig. 32, which shows a section through the crank-pin *P*, and fig. 33, which is a plan or view looking down from above. A stub-end consists of two brass "journal-bearings," or "brasses," *a* and *b*, which embrace the crank-pin and bear against it. These bearings are attached to the rod by the strap or U-shaped bar *S S'*. The strap is fastened to the end of the connecting-rod *R* by the bolts *B B*, and also by a key, *K*, and "gib" or "cotter," *G G'*. A little space, or "clearance," *c c'* is allowed between the gib *G* and the strap *S S'*. When the journal-bearings *a b* wear by reason of their friction on the crank-pin, they are taken out and filed away at *f g*, on their surfaces of contact with each other. The key *K* is then

Fig. 32.



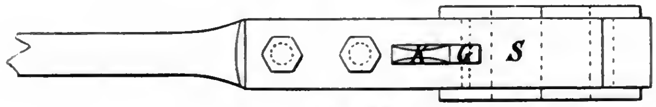


Fig. 33.

driven down, which moves the strap in the direction of the dart *S*—the clearance at *c c'* permitting such movement—which draws the journal bearings together and takes up the "lost motion," as the wear of the journals is called.

QUESTION 78. *Why are the journal bearings made of brass?*

Answer. Because brass resists the wear of a journal, when the pressure on it is very great, better than iron or steel. That is, brass bearings are less liable to get hot or be abraded than either iron or steel.

QUESTION 79. *Are the engines—that is, the cylinders and other mechanism which has been described—which are used in locomotives, similar in principle and construction to stationary engines?*

Answer. Yes, the chief difference is that in locomotives two cylinders and cranks are used so as to overcome the difficulty there would be in starting from the dead-points if only one was used, and the valve gear is also arranged so that the motion of the engine can easily be reversed.

(TO BE CONTINUED.)

Manufactures.

Electric Street-Cars.

THE West End Street-Railroad Company in Boston has now an electric car running, which is provided with a Sprague motor. Power is derived from storage batteries on the Julien system.

A NEW line has been opened from St. Catherines, Ont., to Thorold, 6 miles. The overhead-wire system is used, the electricity being generated at the terminus by a dynamo driven by water power.

THE Lehigh & Wilkesbarre Coal Company is about to put in an electric road at its Stanton Colliery near Wilkesbarre.

Train Telegraphy.

AT the invitation of the Consolidated Railway Telegraph Company, of New York, a large party of electricians and others made a trip upon the Lehigh Valley Railroad, on Thursday, October 6, to inspect the operation of the system of train telegraphy in use upon 54 miles of the road.

The system, due to Edison, Phelps, Gilliland, Smith and others, has been heretofore described, but certain modifications have been introduced which have greatly improved its efficiency, so that as it now stands, all the difficulties heretofore encountered may be said to be overcome.

In the first equipment on the Lehigh Valley Railroad the inductive receiver on the car consisted of a coil of many turns of wire wound around the car, and the line conductor was an insulated wire laid along the track. While this system left little to be desired, it involved some expense which is avoided by the method used at present. This consists in the employment of the roof of the car, where such is available, as a static receiver, and the line is an ordinary wire strung upon short poles near the track.

With the present system the roof of the car is, in most cases, available, and a car can be equipped ready for work in a remarkably short time. All that is necessary is the attachment of a wire to the roof, another to the swivel plate of a car truck for a ground, and the insertion of the instruments in the circuit thus formed. Such was the arrangement of the directors' car which was attached to the special train on the excursion, and the whole equipment did not occupy 10 minutes.

The system, as it exists to-day, briefly stated, consists mainly in the use of the short-pole telegraph line extending along the side of the railroad track at about a distance of 8 or 10 ft. from the line, the poles being much smaller than ordinary telegraph poles, and from 10 to 16 ft. high. At their top is placed an ordinary glass or porcelain insulator, strung upon which is a single galvanized steel (or iron) telegraph wire, about No. 12 American gauge. As remarked before, wherever practicable, the metal roof of the car is employed as the inductive receiver of the car, but where no metal roof exists, an iron or brass rod or tube ½ in. in diameter is employed, placed under the eaves of the car. From the roof, the wire passes to the instruments, and then to the wheels of the car. The roof, or bar, are connected to the secondary of an induction coil. The primary of the coil is connected to the front contacts of a double-pointed key, in which is also included the battery and a buzzer arrangement opposite the core of the coil, for transmitting a series of impulses to the line whenever the key is closed. When the key is upon the front contact also, the extra contact shown at the top of the key closes the secondary circuit and allows the charges to be sent into the roof. When the key is on its back contact, both the secondary and the primary coil are cut out, the charge from the roof passing by the wire from the roof directly to the key and thence through the telephone to earth.

The operator's equipment is quite simple, and consists merely of a small tablet to which the key, the coil and the buzzer are attached, and with just sufficient top surface to hold a telegraph blank conveniently. The battery employed is inclosed in a box and can be placed beside the operator or can be stowed away in one of the closets of the car.

The arrangement at the terminal station, so far as the induction circuits and instruments are concerned, is identical with that on the car; but in addition there is supplied a Morse arrangement, by means of which the line can be used for the transmission of ordinary Morse business. The circuit is made continuous for the induction system by means of a condenser, which transmits the impulses when the Morse key is open.

The cost of equipping a railroad with this system depends somewhat on the character of the roadway, nearness to telegraph-pole markets, etc.; but it is said to approximate about $50 per mile for line equipment, poles, wire, etc., and the labor of putting up. The cost of fitting a car is about $15.

On this trip, a large number of messages were sent and received from the train without the slightest delay of any kind, the arrangements being under the charge of Mr. S. K. Dingle, Assistant Superintendent of the Company.

One of the most striking demonstrations of the wide application of the system was the sending of a dispatch from the rapidly moving train to Mr. John Pender, of London, England, *via* the Atlantic cable.

Marine Engineering Notes.

CRAMP & SONS in Philadelphia have taken a contract to build a steamboat to run between New York and Sandy Hook on the New Jersey Southern route to Long Branch. The boat will be 265 ft. long, will have twin screws and triple-expansion engines, and is to be very fast.

THE W. & A. Fletcher Company in New York have the contract for a compound beam engine and a pair of Morgan iron feathering wheels for the new steamboat *City of Detroit*, for the Detroit & Cleveland Steam Navigation Company. The engine will have a high-pressure cylinder, 44 in. diameter and 8 ft. stroke and a low-pressure cylinder, 68 in. diameter and 12 ft. stroke.

THE steamer *Gogebic*, recently launched from the Wheeler yard at Bay City, Mich., is 275 ft. keel, 40 ft. beam and 22 ft. depth of hold. Her engines were built by the Frontier Iron & Brass Works, of Detroit, and are of the triple-expansion type, with cylinders 20, 32 and 52 in. diameter by 40-in. stroke, being a duplicate of those furnished the steamer *Sitka*, launched at the same yard in August.

THE steamer *Frank L. Vance*, recently launched from the Radcliff yard in Cleveland, O., has the following dimensions: Keel, 255 ft.; over all, 273 ft.; beam, 39 ft.; hold, 21 ft. She has three steel arches, two on the outside and one on the inside. There are two steel boilers, 9 by 15 ft., and a compound-engine, cylinders 28 and 50 in. diameter, with 45-in. stroke. She carries three masts.

THE Quintard Iron Works in New York recently completed the engines for the lake steamer *Owego*. They are to work under a boiler pressure of 160 lbs., and the cylinders are 28 in., 42½ in. and 72 in. diameter, and 54 in. stroke. These engines are managed from the lower engine-room from the level of the shaft. Steam will be supplied by six boilers, each 11½ ft. diameter, and each having two of Fox's corrugated furnaces, 39 in. diameter and 6 ft. long.

THE new steamer *Yakima*, built at Quayle's ship-yard in Cleveland, O., measures 275 ft. keel, 292 ft. over all, 40 ft. beam and 22 ft. hold. She has steel arches, is diagonally steel-strapped, and has a steel cord around the top. Her boilers are 13 by 12 ft., and the cylinders to her engine are 30 and 56 in., with 48-in. stroke. Her carrying capacity is 2,200 tons. She cost $125,000. She is fitted out with all modern improvements and is to be lighted with electricity.

NEAFIE & LEVY in Philadelphia are to build a new steamer for the Oregon Improvement Company, for service on the Pacific Coast. The new steamer will be 230 ft. long, 34 ft. 6 in. beam and 25 ft. 3 in. depth, molded dimensions. She will be provided with the latest design of triple-expansion engines, with cylinders 20, 31 and 51 in. diameter, by 36-in. stroke. Boilers of steel, 4 in number, 10 ft. diameter by 11 ft. long, to carry 150 lbs. steam pressure.

THE Harlan & Hollingsworth Company in Wilmington, Del., has begun a new steamboat to run on Chesapeake Bay for the Maryland Steamboat Company. The boat will be 200 ft. long, 31 ft. beam and 10 ft. deph of hold. The engine will be surface condensing, 42 in. diameter of cylinder by 10-ft. stroke. The paddle-wheels will be 22 ft. in diameter and have feathering buckets. She is to be finished in time for service next summer.

Manufacturing Notes.

THE South Tredegar Iron Works in Chattanooga, Tenn., are running on heavy orders for rail-joints and spikes.

THE Ensign Manufacturing Company at Huntington, W. Va., has begun to build a new erecting shop, 100 by 108 ft. The shops are now turning out 11 freight cars a day.

THE Brown & Sharpe Manufacturing Company is adding to its works in Providence, R I., a new four-story brick building 195 by 51 ft., with a wing 40 by 40 ft. in size.

THE Rhode Island Locomotive Works in Providence are building several ten-wheel freight engines for the Western & Atlantic Railroad.

THE Elliott Car Works at Gadsden, Ala., are nearly ready for work. The buildings include two shops, each 50 by 200 ft., and a round-house 234 ft. diameter, to be used as an erecting shop.

A NEW rail-mill is nearly completed at the Edgar Thomson Steel Works at Braddock, Pa. It will have a capacity of 1,000 tons of rails per day, running double-turn. The new mill has three engines of 1,200 H. P. each, built by E. P. Allis & Co., of Milwaukee.

RIEHLE BROTHERS, proprietors of the Philadelphia Scale Works, have recently received large orders for track and wagon scales, charging scales for furnaces and testing machines, and are very busy.

THE buildings for the South Baltimore Car Works are nearly completed, and it is expected that the works will be in operation early in November. Several rows of neat dwelling houses and stores are about completed close by, streets laid out, paved and curbed, forming the nucleus of a small town.

THE Union Switch & Signal Company in Pittsburgh has recently received large orders for signals for the New York, New Haven & Hartford, the New York & Northern, the New Jersey Central, the Philadelphia & Reading and the Minnesota & Northwestern roads.

THE Nashville (Tenn.) Iron, Steel & Charcoal Company is now pushing to completion two charcoal-iron furnaces in West Nashville, 12 by 60 ft., having two 5-in. stoves, 15 by 55, to each furnace, and two blowing engines with 36 by 48-in. steam and 48 by 48-in. blowing cylinders.

THE Smith, Beggs & Rankin Machine Company in St. Louis will build two engines, each 24 by 48 in. for the River View and Eighth Street Cable Railways, both Kansas City roads. For the proposed light rail mill of the Belleville Nail & Steel Works, they have an engine, 30 by 60 in., nearly completed.

VERY heavy steel plates are now being manufactured at the Linden Steel Works, near Pittsburgh. On October 1, among other large armor-plates for the United States Government's new cruisers one was rolled weighing almost 10,000 lbs., the dimensions being about 19 ft. long by 6 ft. wide and 2 in. thick. This is said by the Linden Steel Company to be the heaviest steel plate ever rolled on this side of the Atlantic.

THE Columbus Machine Company, Columbus, O., is building a blowing engine for parties at Shawnee, O. The principal dimensions are as follows: Blowing cylinder, 84 in.; steam cylinder, 40 in.; stroke, 48 in.; weight, 85 tons. Similar engines are under construction for parties in Alabama and Kentucky. These engines embrace a number of late improvements

THE silica-graphite paint made by the Joseph Dixon Crucible Company in Jersey City, N. J., was prepared originally for use on smoke-stacks, boiler-fronts and other iron work which is subject to extreme temperatures and sudden changes. It is a mixture of perfected graphite and pure linseed oil, and several years' use has thoroughly tested it. It is now used by a number of railroads and manufacturing firms.

THE Union Switch & Signal Company is putting in a complete system of signals and interlocking switches for the Baltimore & Ohio Railroad at Camden Station, Baltimore. The tower contains 56 levers, and is tastefully built of pressed brick, with brown stone trimmings. The tracks are being relaid with heavy rails, stone ballasted, with frogs, switches and signals of the latest and best design.

THE H. S. Hopkins Bridge Company in St. Louis has taken the contract for a new bridge over the Missouri River at Omaha, Neb., which is to be owned by a local company. The bridge proper will have seven spans, one of 400 ft., two of 250 ft. and four of 150 ft. each. There will be 900 ft. of iron viaduct on the east side and 925 ft. on the west side, making the total length of the structure about 3,350 ft.

THE Watts-Campbell Company in Newark, N. J., has recently completed a pair of tandem compound engines for the Shrewsbury Thread Mill in East Newark. These engines have high-pressure cylinders 20 in. and low-pressure 36 in. diameter and 48 in. stroke. The valve-gear is of the Corliss type, somewhat modified. The fly-wheel is 25 ft. diameter and 6 ft. 2 in. face; it carries two 28-in. and one 10-in. belt.

THE iron mines of Northern New Jersey are working more actively than for several years past. The Sherman and Bedell mines near Sparta have recently been re-opened by Cooper, Hewitt & Co. The Kishpaugh mine near Hope; the Dunker mine near Stockholm, and the Canisteer mine have also recently been re-opened. The Judson mine at Stanhope is being

worked by the Flanders Iron Company, and several mines have been opened along the line of the new Morris County Railroad.

AMONG the many improvements which the Pennsylvania Company is making in the shops at Fort Wayne, Ind., is the electric-light plant, which consists of six dynamos, two incandescent and four arc, capable of supplying 260 incandescent lights of 16-candle power, and 120 arc lights of 1,600-candle power. The arc lights will be used in the yards and as a general light in the shops, and in the machine-shop the incandescent light will be used at the machines instead of gas. All the shop offices will be supplied with incandescent lights. The Ball dynamo will be used.

THE new bridge over the Missouri River at Randolph, near Kansas City, built for the Chicago, Milwaukee & St. Paul Railway, is now completed. The total length of the bridge is 7,392 ft. There are three main spans of 400 ft. each, with trusses 50 ft. high and 23 ft. apart, each with 16 panels 25 ft. each. There is one deck span 160 ft. long, 1,545 ft. of iron viaduct, averaging 51 ft. in height above the ground and 22 ft. wide on top for double track; 2,775 ft. of timber trestle work, from 26 to 47 ft. high, and 1,590 ft. of pile bridge, from 15 to 26 ft. in height. There are five masonry piers. The four main piers supporting the 400 ft. spans rests upon rock, and the fifth pier rests upon pile foundation. The height of the channel piers is 92, 112 and 122 ft. The shore piers are 56 and 45 ft. in height. There are 82 pedestal piers, 14 ft. in height, resting upon pile foundations. These pedestal piers support the iron viaduct. The contractors for the pier foundations were Sooy-Smith & Co.; for the iron viaduct, M. Lassig; and for the bridge superstructure, the Keystone Bridge Company.

Proceedings of Societies.

New England Railroad Club.

THE regular meeting was held in Boston, October 12. The subject was Car Heating and Ventilation. Mr. J. G. Pennycuick, manager of the Pennycuick Heat & Ventilation Company, explained its system of heating cars and the operation of the automatic steam coupler controlled by the company.

Mr. Walter G. Chase explained the construction and working of the Mason reducing valve.

Mr. Nelson Curtis explained the Curtis pressure regulator.

Mr. Joseph A. Shinn described the system of car heating owned by the Safety Car Heating and Lighting Company of New York.

Mr. Sewall, of Portland, told of the successful practical test of heating a train with steam from the locomotive.

It was voted to discuss at the next meeting the subject of "Best Material for Axles, Journal Bearings and Lubrications."

American Institute of Electrical Engineers.

THE first monthly meeting of the season was held in New York, September 20. After dinner had been disposed of, as usual, a paper was read by Mr. Anthony Reckenzaun, of London, England, on Electric Street Cars, with Special Reference to Methods of Gearing. This paper was long and treated the subject in an exhaustive manner; it was followed by a discussion, in which many members took part.

New York Railroad Club.

A REGULAR meeting was held in New York, October 20, at which the subject of Car Heating and Lighting was discussed.

The proposition to change the name of the association from the Master Car-Builders' Club to the New York Railroad Club was approved.

Western Society of Engineers.

A REGULAR meeting was held in Chicago, October 4. Messrs. Moritz Lassig and George H. Bremner were elected members. Mr. L. P. Morehouse tendered his resignation as Secretary.

Mr. Lundie presented a short paper containing a formula, and its mathematical demonstration, for determining the Economical Proportions of Truss Bridges. A discussion of this paper, when printed, is invited by the author.

American Society of Railroad Chemists.

A MEETING of this Society was held in Omaha, Neb., early in October. The subjects brought up before the meeting for discussion were: Vehicles of Paint; Linseed Oil; Uniform Methods for the Analysis of Coal so as to ascertain its commercial value; Analysis of Car Brasses and Babbitt, and of Soap for Washing Cars; Best Methods of Preservation for Ties and Bridge-timber; Fireproof Paints; Fire-extinguishers; Methods of Heating and Lighting Cars. Lubricating oils and car paints were also brought up for consideration.

All the railroads having organized chemical departments are now represented in this Association.

Western Railroad Club.

A REGULAR meeting of this Club was held in Chicago, October 19. The best Form and Dimensions of Axle for 60,000-lbs. Cars was discussed by a number of members.

The Committee on Car Heating made a report recommending the appointment of a Committee to confer with railroad companies and secure the adoption of a uniform standard coupling for steam-heated cars. The report was adopted, and Messrs. W. Forsythe, J. N. Barr and W. A. Scott were appointed as the Committee.

General Time Convention.

THE fall meeting was held in New York, Oct. 12. The Committee on Uniform Train Rules presented its final report. The code of Telegraphic Train Orders and Rules was finally adopted with only two dissenting votes.

The questions of changing the system of payment for use of freight-cars (as recommended by the Car Accountants' Association) and of telegraphic distribution of accurate time were referred to Committees to report at the next meeting.

Association of North American Railroad Superintendents.

THE regular semi-annual meeting was held in New York, October 10. The Association voted to adopt the M. C. B. standard axle and journal-box, but refused to make any recommendation as to couplers for passenger cars. It also recommended the adoption of a general form of record for through trains.

Other subjects discussed were the Distribution of Time-tables; Demurrage on freight-cars; Charges for use of passenger-cars; Frogs and switches, and Track inspection.

Roadmasters' Association of America.

THE annual convention was held in Cleveland, O., October 11, and continued three days.

Discussions were had on Standard Weight of Rails; Guard Rails; Frogs and Switches; Rail-joints, and Hand-cars.

The following officers were elected: President, J. W. Craig; Vice-Presidents, I. Burnett, James Sloan; Secretary and Treasurer, H. W. Reed.

New England Roadmasters' Association.

THE annual meeting was held in Hartford, Conn., October 19, and lasted two days. The subjects discussed were: Guard Rails; Foot-guards for frogs and switches; Economy in maintenance of track, and Track on bridges.

The following officers were elected: President, W. A. Lane; Vice-President, J. R. Patch; Secretary, W. Ellis; Treasurer, George Nevens; Chaplain, E. W. Homer; Executive Committee, P. A. Eaton, L. H. Perkins, George Bishop.

Engineers' Club of Kansas City.

A REGULAR meeting was held October 3, J. A. L. Waddell, Vice-President, presiding; T. F. Wynne, Secretary *pro tem.* Messrs. E. W. Stern, Chas. H. Talmage, and Chas. W. Hastings were elected members.

The paper of the evening on the Construction and Operation of the Ninth Street Cable Railway, prepared by M. K. Bowen, was read by C. G. Wade.

Mr. Kiersted was invited and consented to read a paper at the next meeting, subject to be announced.

American Street-Railway Association.

THE sixth annual convention began in Philadelphia, October 19, with a large attendance. The report of the Executive Committee showed that the Association had increased its membership from 140 companies to 153 companies during the year. The report also spoke at length of the labor troubles of the year.

Mr. C. A. Richards, of Boston, read an elaborate paper on Roadway Construction, which was followed by a long discussion.

Mr. William Wharton, Jr., of Philadelphia, read a paper on Electricity as a Motive Power. He treated of the methods of transmitting power by means of overhead wires, by conduits and by storage batteries, arguing in favor of the latter method.

F. J. Sprague, of the Sprague Electric Railway & Motor Company, also spoke in the same vein.

A paper upon Motors Other than Cable or Electricity, prepared by D. Atwood, of Milwaukee, was also read.

On the second day Mr. Moses Humphrey, of Concord, N. H., read a paper on Eight-wheeled Cars, advocating their use on street railroads.

A paper on Street Railway Mutual Fire Insurance, by John Maguire, of Mobile, Ala., was read by William J. Richardson, of Brooklyn. The plan suggested by Mr. Maguire was referred to a Committee composed of Messrs. Woodward, of Rochester; Frazier, of Memphis; Moss, of Sandusky, O.; Swain, of New York, and Crossin, of London, Canada.

Mr. C. A. Vandepoele, of the Vandepoele Electric Company, of Chicago, addressed the convention on the subject of Electric Railroads, stating it as his belief that electricity would finally supersede every other motor on street railroads. The subject was discussed at length during the afternoon.

Elias E. Ries read a paper on A New Method of Increasing the Tractive Adhesion of Driving-wheels.

The following officers were elected for the ensuing year: President, Charles B. Holmes, Chicago; First Vice-President, Julius E. Rugg, Boston; Second Vice-President, Dudley R. Frazier, Memphis, Tenn; Third Vice-President, Charles B. Clegg, Dayton, O.; Secretary and Treasurer, William J. Richardson, Brooklyn, N. Y.; Executive Committee, Thomas W. Ackley, Philadelphia; Winfield Smith, Milwaukee; Daniel F. Lewis, Brooklyn, N. Y.; Charles Green, St. Louis, and Edward G. Mosher, Augusta, Ga.

The next convention will meet in Washington, on the third Wednesday of October, 1888.

Engineers' Club of Philadelphia.

AT the last spring meeting of this Club, on June 18, the following new members were elected:

Active Members: W. H. Frances, P. Doyle, John C. des Granges and Francis W. Whiting.

Associate Members: Robert Neilson and Horace B. Powell.

At the same meeting, Mr. John L. Gill, Jr., presented a description of a New System of Screw Threads which he had arranged, and asked that a committee be appointed to examine and report upon the same. The President appointed the following committee: Henry G. Morris, Chairman; John T. Boyd, Professor L. M. Haupt, Washington Jones and M. R. Muckle, Jr.

THE first fall meeting was held at the Club's House in Philadelphia, October 1, Past-President Washington Jones in the chair; 30 members and 4 visitors present.

Mr. J. M. Cameron, introduced by Mr. Henry G. Morris, described the Carnell Air Injector.

This machine is intended to supply air to the furnaces of steam boilers of all classes. Steam is taken from top of boiler and carried through the combustion chamber, where it is heated to about 900° Fahr., then to a distributing apparatus discharging under the grate. The steam, heated to the condition of a gas, takes with it the necessary air for combustion. It is claimed that the heat to which the steam is raised, in connection with a reduction of pressure to 20 lbs. per square inch, increases the relative volume to 1,800, which would be eight times more effective than saturated steam. The heat taken from combustion chamber is given out to the air entering the furnace. Tests are said to have shown an increased boiler power of 28 to 100 per cent., with a proportionate saving in fuel of 2 per cent. above that obtained by natural draft.

Mr, Henry G. Morris exhibited and described a working model of a Traveler to Carry Wires, Ropes, etc., through Conduits, which he had devised.

The apparatus consists of two parts, one placed ahead of the other, and each provided with spring claws, which will slide ahead in the conduit, but will take hold of the sides and prevent any backward motion. The parts are operated by two cords working on a system of pulleys, so that, by the alternate pulling of the cords, the whole apparatus will move ahead of the operator through the conduit. That is to say, pulling one cord will drag the rear piece up to the front piece, and pulling the other cord will send the front piece a distance ahead, each part, with the attached pulleys, holding firmly to the sides while the other part is being moved.

Prof. L. M. Haupt made some remarks upon his Experiments with Current Deflectors at Five-Mile Bar, and showed how urgently the City and river interests required a channel across it. He then suggested a plan whereby he proposed to create a channel sufficient to meet the demands of commerce, upon the following principles:

1. If the *bottom velocity* of a stream be increased to the limit by the character of the material forming its bed, it will scour; if diminished, it will deposit.

2. If the *momentum* of a stream be suddenly arrested by an obstruction placed in its path, a reaction will be produced, its head will be increased, and the bottom will be scoured out.

3. If the *volume* of a stream be partially deflected by a trailing wall, from one side of a cross-over bar to the opposite side, the current over the bar will be quickened and the crest lowered above the line of the works.

4. If the *form* of the cross-section of a stream be modified by cutting at one point and filling at another point of the same section so that the area is not changed, other things being equal, the discharge will not be materially affected, and the part so deepened will remain open.

5. If a stream be compressed laterally into a smaller section, ts velocity head near the banks will be increased, while that at the center will be diminished, and consequently the channel will be bifurcated and the deepest water be found near shore.

If, by the application of these laws of flowing water, a channel, sufficiently wide and deep for navigation, be cut across a bar, it will be self-sustaining, and cost much less than if the entire bar were disturbed by the usual lateral dikes or by dredging.

The Secretary announced the death, since the summer adjournment, of Mr. Frank Maddock, Active Member of the Club.

American Society of Civil Engineers.

A REGULAR meeting was held at the Society's House in New York, October 5, which was devoted entirely to business.

Mr. J. P. Davis presented a resolution providing for the appointment of a Committee to consider and report an amendment to the Constitution relative to the mode of electing members.

This resolution was discussed by Messrs. Davis, Wellington, Dorsey, North, Bogart, O'Rourke, Croes and Brinckerhoff, and was finally passed; the President appointed on the Committee Messrs. Davis, Wellington and Paine.

A report was received from the Committee appointed at the last convention to consider and report on the advisability of creating the grade of Student in the Society. After discussion by Messrs. Croes, Paine, North, Davis, Bogart and Wellington, it was resolved that the report be accepted and printed for distribution to Members, and that the Committee be continued, with a request that a further report be presented at the meeting of the Society on the first Wednesday in November. The report will be found below.

The following elections were announced:

Members.—Henry St. Leger Coppee, Vicksburg, Miss.; Henry Clay Derrick, Halifax Court-House, Va.; Joseph Norton Greene, Willimantic, Conn.; Edward Buckingham Guthrie (elected Associate September 3, 1884), Buffalo, N. Y.; Charles Edward Hewitt, Trenton, N. J.; Wynkoop Kiersted, Falls City, Neb.; James Imbrie Miller, Tarrytown, N. Y.; Palmer Chamberlaine Recketts, Rochester, N. Y.; Granville Wheaton Shaw, Louisville, Ky.

Associate.—Gratz Mordecai, Washington, D. C.

A meeting was held at the Society's House in New York, October 19. The first paper presented, through Mr. E. P. North, was on Brick-Making in Sinaloa, Mexico, by Juan José Avela.

The Secretary then read papers on Cement Tests, by Emil Kuichling and E. B. Noyes. These were generally discussed by members present.

A circular issued by the Secretary, in accordance with the action noted above, refers to the resolution adopted at the meeting at the Hotel Kaaterskill in July last, on the question

of creating the grade of "Students" of the Society, and presents the report of the special Committee to which that resolution was referred. This report, which is signed by Messrs. Robert E. McMath, Robert H. Thurston, W. H. Paine and Robert Moore, is in substance as follows:

"In considering the advisability of creating this new grade of membership, we have taken into full account the only objection that has been raised to such action; that it would lower the standard of the Society. If there be danger of such result, then your Committee would certainly report that the proposed action is not advisable. If membership of the Society is to remain as now established, then to add a lower grade would, in a certain sense, lower the average of the Society and so afford some ground for the objection. If, on the other hand, the creation of a new grade is made the occasion of an advance in the standard of qualification for the higher grades, then the spirit of the objection is an argument for the proposed action. Another consideration influences your Committee, which is, that we find scant room for a grade of students below the requirements for the present class of Junior. We therefore say, decidedly, that if the Society is unwilling to raise the standard of qualification required for membership in grades now established, then it is inexpedient and not advisable to create the proposed grade of students.

"But if the Society is ready to raise the standard for all grades, then we say the creation of the proposed grade of students is expedient and advisable.

"To test the disposition of the Society, and with confidence that it is ready for a step in advance, we report in favor of the adoption of the accompanying amendments and resolution:

AMENDMENTS TO THE CONSTITUTION.

"ARTICLE XVI. The active members of the Society shall be divided into three classes, to be styled respectively Members, Associate Members and Associates; and each person, when duly elected and qualified, shall receive a certificate of Membership indicative of the class to which he belongs.

"Associate Members shall have all the rights and privileges of Members excepting the right to hold office or to vote upon admission to membership. Associates shall have all the rights and privileges of Members excepting the right to hold office or to vote.

"There shall also be a preparatory grade, to be designated Students of the Society, who shall have the right to attend all meetings not strictly devoted to business, and to use the library and rooms of the Society under such regulations as the Board of Direction may adopt. They shall have by right the *Transactions* of the Society and the privilege of presenting papers and written discussions.

"Members of the class previously styled Juniors, shall, after March 7, 1888, be classed as Associate Members.

"ARTICLE XVII. A Member shall be a Civil, Military, Mining or Mechanical Engineer, not less than 30 years of age, who has been in active practice as such for at least ten years or has graduated at a school of engineering after a full course of study and been in practice seven years, and who continues in actual practice at the time of application for membership, and who has had responsible charge of work as Chief, Resident or Superintending Engineer for at least two years, not as a skillful workman merely, but as one qualified to design as well as to direct engineering works.

"An Associate Member shall be one over 24 years, who has had actual practice in some of the branches of Civil, Military, Mining or Mechanical Engineering for at least five years; or, if a graduate of a school of engineering after a full course of study, who has practiced at least two years.

"An Associate shall be one over 25 years of age, who is a manager of a railroad, canal or other public work; a geologist, chemist or mathematician; a proprietor or manager of a mine or metallurgical works; an architect or a manufacturer; or one who, from his scientific acquirements, or practical experience, has attained eminence in his special pursuit, qualifying him to co-operate with engineers in the advancement of professional knowledge; but shall not himself be practicing as an engineer.

"A Student shall be one not less than 18 years of age, who is engaged in the study of engineering with the intent to become an engineer, and who has pursued that study at a technical school not less than one year, or who shall have been engaged in the study and practice of engineering under a competent engineer for not less than two years. A Student shall not remain in that grade for more than seven years; if not elected to a higher grade his connection with the Society shall terminate at the end of seven years.

"ARTICLE XVIII. Insert after 'Society,' at end of first line of printed copy, the words, 'except to the grade of Student.'

"Also, ARTICLE XVIII. (Insert at end of first paragraph) 'Nominations for Students shall be made out as for other grades, but the endorsement may be signed by a Member, Associate Member or Associate, and but one such signature will be required. Such nominations shall follow the usual course of procedure for other grades except submission to a letter ballot. The Board of Direction shall elect or reject the applicant.'

"The resolution fixing entrance fee and annual dues for Associate Members and Students is as follows:

"*Resolved:* In the event of the Society adopting amendments to the Constitution creating the grades of Associate Member and Students of the Society, that the entrance fee and annual dues of Associate Members shall be the same as established for Associates; for Students no entrance fee shall be required, and the annual dues shall be, for resident Students, $10 and for non-resident Students, $6 per annum."

A supplement to the report is added by the Committee giving its reasons in detail for the proposed changes. Mr. Frederick Brooks, a member of the Committee, made a minority report presenting amendments differing from those given by the majority in some details, and retaining the name of Junior for the grade called Associate by the Committee

Master Car-Builders' Association.

AT a recent meeting of the Executive Committee in New York, it was announced that on the question of adopting the Janney type of car-coupler as the standard of the Association, the letter-ballot stood: For, 474; against, 194. Over two-thirds of the vote being in favor of the standard, it is declared adopted.

The other standards submitted to letter-ballot at the same time (Draft-rigging for non-automatic couplers; Axle and journal-box for cars of 60,000 lbs. capacity; Sizes of lumber for freight cars) failed to receive a two-thirds vote and were not adopted.

The resignation of the Secretary was considered, but the Committee declined to accept it.

The following resolution was adopted at this meeting:

"*Resolved*, That a sub-committee of five be appointed to critically examine the different forms of couplers coming within the Master Car-Builders' type, and report the result of their examination to the Executive Committee on the second Thursday in January, 1888, for their further action."

Messrs. Wall, Wade, Lentz, Cloud and Forney were appointed such Committee.

PERSONALS.

Mr. H. L. Cooper has resigned his position as Superintendent of Equipment of the Lake Erie & Western Railroad.

Mr. M. Reedy has been appointed Roadmaster of the St. Louis, Vandalia & Terre Haute Railroad.

Commander Edgar C. Merriman, U. S. N., has been detailed as Equipment Officer of the Boston Navy Yard,

Mr. P. Reilly has been appointed Superintendent of Equipment of the Lake Erie & Western Railroad, with office at Lima, O., in place of H. L. Cooper, resigned.

Mr. B. C. Bosworth has been appointed Superintendent of Machinery of the Colo Midland Railroad, with office at Colorado Springs, Col., succeeding William Fuller, resigned.

Colonel Henry G. Prout has retired from the firm of Atkin & Prout, printers, and will hereafter devote his whole time to his duties as Managing Editor of the *Railroad Gazette*.

Mr. William Torrence has been appointed Master Mechanic of the Ohio Valley Railroad, with headquarters at De Koven, Ky.

Mr. W. H. Brinckerhoff, M. Am. Soc. C. E. has accepted a position on the editorial staff of the *Engineering and Building Record* (late the *Sanitary Engineer*), of New York.

Assistant Naval Constructor John B. Hoover, U. S. N., has been ordered to special duty in connection with the new cruisers now building at Cramp's yard in Philadelphia.

Mr. Samuel Thomas has resigned his position as President of the Thomas Iron Company, after nearly 35 years' service, on account of continued ill health.

Mr. David L. Barnes has resigned as Chief Draftsman of the Rhode Island Locomotive Works and will open an office as consulting engineer.

Mr. Arthur C. Moore has charge of the surveys and plans for new water-works for the town of Brookfield, Mass. He has just completed plans for a new reservoir for the Southbridge water-works.

Mr. Edwin Thacher, Chief Engineer of the Keystone Bridge Company, has accepted the position of Chief Engineer to the Decatur Bridge Company, recently organized at Decatur, Ala., and will proceed to his new field shortly.

Mr. A. Gordon Jones has been appointed Superintendent of the Little Rock & Memphis Railroad, with office at Memphis, Tenn. He was formerly on the Baltimore & Ohio Railroad.

Mr. S. Wright Dunning, formerly Editor of the *Railroad Gazette,* sailed from New York, September 27, on an extended trip to Europe. He is accompanied by Mrs. Dunning, and purposes spending at least two years abroad.

Mr. C. F. Resseguie has been appointed Superintendent of the Idaho Division of the Union Pacific, with office at Pocatello, Idaho. He has been for 11 years on the Chicago, Burlington & Quincy, and was recently Superintendent of the Illinois lines of that road.

Mr. J. C. Monroe has been appointed Master Mechanic of Kansas City, Memphis & Birmingham Railroad, with office in Memphis, Tenn. He was recently on the Missouri Pacific at Palestine, Texas.

Mr. Robert Garrett has retired from the office of President of the Baltimore & Ohio Railroad Company in consequence of recent charges in the control of that company. Mr. Garrett is not at present in good health, and has gone to Mexico on a long trip. Reports have been circulated that his mind is affected, but they do not appear to rest on any very reliable basis.

Mr. E. H. Walker, for many years Statistician of the New York Produce Exchange, has joined the editorial staff of *Bradstreet's,* the well-known commerical and financial newspaper published in New York, to which he will give his exclusive services. Mr. Walker is perhaps the best informed man now in the country on the statistics of grain, flour, provisions, live stock and kindred lines.

Mr. John D. Kernan, Chairman of the Board of Railroad Commissioners of the State of New York, has resigned his office, to date from November 14. Mr. Kernan expects to resume the practice of law in New York City. He has been active in the work of the New York State Commission, especially in connection with the drafting of amendments to the general railroad laws and Legislation for the regulation of railroads and the protection of the traveling public and railroad employés. The accurate compilation of the railroad law of the State, contained in each annual report of the Board and prepared under his supervision, is highly spoken of by lawyers. The weight given to his recommendations as to National railroad legislation by the Cullom Committee of the United States Senate led to the general belief that he would be appointed an Inter-State Commerce Commissioner last spring.

NOTES AND NEWS.

A Mountain Tramway.—The Gilpin Tramway Company is building a road of 2 ft. gauge to carry ore from mines in the mountains near Central City, Col., to the mills at Blackhawk. The line, which is more than half finished, is 10 miles long, and is nearly all on a grade of 3½ per cent., or 185 ft. to the mile. It will be equipped with 2 locomotives of the Shay pattern, made at Lima, O., and 100 ore cars.

Electric Lighting of Cars in Russia.—The Russian Minister of Railroads has appointed a commission to select a method of lighting railroad cars with electricity, and all the principal companies will hereafter be compelled to use the light on passenger trains. The South Russian Railroad has for some time used electric light on all its fast trains from Odessa to Kieff, and the Czar's special trains have been so lighted for a long time.

Proposed New Russian Canal.—The Dwina and the Dnieper are to be joined by a new canal which will connect the River Loutchesa, flowing into the Dwina near Vitebsk, and the River Ochitcha, flowing into the Dnieper. This project also entails deepening and improving the means of navigation on the Dwina and on the Dnieper, which will cost 2,000,000 roubles, while the cost of the construction of the canal is estimated at 8,000,000 roubles ($3,600,000).

The French Exposition of 1889.—Official notice has been issued that the Committee of Class 61 (which includes material of all kinds for railroads and tramways, cars, engines, etc.) has been organized. Its first work is to determine how much space will be needed for exhibits of this class, and for this purpose those who intend to exhibit are urgently requested to notify the Committee at the earliest possible date of the amount of space they will require and of the nature and extent of their exhibits.

Baltimore & Ohio Employes' Relief Association.—The August sheet of this Association shows payment of benefits as follows:

	Number.	Amount.
Accidental deaths	3	$4,500
Accidental injuries	357	4,958
Natural deaths	15	7,750
Sickness	608	8,798
Physicians' bills	258	1,453
Total	1,241	$27,459

From the foundation of the Association in 1880 it has paid out in all $1,482,301 in benefits.

The Vanderbilt Building.—The new building in New York, given by Mr. Cornelius Vanderbilt for the benefit of the employés of the New York Central & Hudson River road, was formally opened October 3, when speeches were made by Mr. Vanderbilt, Bishop Potter, Mr. Chauncey M. Depew and others to a large number of invited guests.

The building will be under the charge of the Young Men's Christian Association. It has on the first floor a library containing 6,000 volumes, a reading room, social room and bathrooms. On the second floor is a large hall for meetings, etc. In the third floor is the recreation room, comfortably fitted up with lounges. Here the men can get hot coffee free of charge, while all the cooking appliances necessary for a restaurant are on hand. In the top floor is a large room fitted up with brass bedsteads for the use of railroad men compelled to stay in the city over night. Everything is most handsome and complete.

Railroads in Colombia.—Mr. E. W. P. Smith, Consul at Carthagena, Colombia, writes to the State Department: "A Franco-Belgian syndicate of capitalists has just secured a most important concession from this Government for the construction of two grand trunk lines of railroads between a port on the Atlantic and one on the Pacific to Bogota. The Government, in addition to a guarantee of 7 per cent. on a capital of $80,000,000, gives the company large land grants, and exempts from contribution and import duties all material and supplies that may be introduced into the country by the company. This enterprise could have been secured by American capitalists had they sent proper representatives out here to obtain it.

"An enterprising American has obtained the privilege of constructing a tramway in this city, and has gone home to obtain the necessary outfit for its mimediate construction."

The Cairo Bridge.—The bridge over the Ohio River at Cairo, Ill., for the Illinois Central Railroad will have 12 spans, two of 518½ ft. each, center to center of piers; seven of 400 ft. each and three of 250 ft. each, making the total length 4,670 ft.

The approaches will be wooden trestle, to be filled with earth by train after the bridge is open for traffic.

The clearance line of the superstructure is 53 ft. above extreme high water. High water mark is 52.17 ft. above extreme low water. The foundations in the river will be at least 75 ft. below low water, so that the total height of piers will be about 180 ft.

The foundations in the river will be sunk by the plenum pneumatic process. The caisson will be surmounted by a crib filled with concrete, and the total height of the caisson and crib will be 50 ft. The masonry will be built of stone from Bedford, Ind., except the up-stream nose stone, between high and low water, which will be of granite. The superstructure will be entirely of steel, except pedestal castings and some unimportant parts. The plans are now prepared in detail, and the work is well under way.

The entire work will be completed by the close of 1889, about 2½ years from the date of commencing the work. The entire cost is not expected to exceed $2,500,000. The bridge is single track.

The plans have been made by and the work is under the charge of Messrs. Morison & Corthell, with Mr. Alfred Noble as Resident Engineer.

The Union Bridge Co., of New York, have the contract for nearly all the work on the main bridge.

Railroads in Hayti.—Mr. John E. W. Thompson, Consul-General to Hayti, writes to the State Department as follows: "A law sanctioning the contract for the building of a railroad from the city of Gonaïves to Gros Morne, a distance of about 24 miles, with eventual termination at Port de Paix, was published in the *Moniteur* of the date August 19, 1886. This contract has been made with a French firm, who some years back sent engineers exploring into that part of the country, and who evidently found the condition particularly rich and profitable for the scheme, because ever since they have been striving to get the concession, and the only subvention given by the Government consists in the wood found in a parallel of 10 kilometers to the right, and 10 to the left of the line on the public ground of the State. It is said that the above named country abounds in forests of the finest quality of mahogany and logwood, and these valuable products, owing to there being no mode of transporting the same to the sea-ports, could not be utilized for exportation. The line is to be entirely finished at the expiration of 28 months; also the rails are to be laid to the wharves, in order to communicate directly with vessels loading.

"Such an enterprise embodies results of more or less significance. If successful, it will be the means of causing similar lines to be laid at available points and thus opening up anew the exportation of articles now difficult to obtain. Brazil-wood and other valuable woods which have a marked value are now unavailable for want of roads and means of transportation to the seaboard cities."

Blast Furnaces of the United States.—The *American Manufacturer* says: "Our usual monthly statement of the condition of the blast furnaces of the United States, on October 1, in a condensed form, makes the following showing:

	In blast.		Out of blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	73	15,171	104	11,420
Anthracite	122	36,044	79	19,234
Bituminous	151	93,423	61	25,505
Total	346	144,638	244	56,159

"There has been a reduction during the month of total number of furnaces in blast of 6. There are 6 less charcoal furnaces blowing, 8 less anthracite and 8 more bituminous.

"As compared with a year ago, the condition of the furnaces in blast is as follows:

	Oct. 1, 1887.		Oct. 1, 1886.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	73	15,171	66	11,105
Anthracite	122	36,044	121	34,091
Bituminous	151	93,423	132	76,270
Total	346	144,638	319	121,476

"The most notable feature of the report for this month is the large number of coke furnaces in blast, 151, with a weekly capacity of 93,423 tons. This is the largest number of coke or bituminous furnaces and capacity ever reported as blowing, the nearest approach to it was April 1, 1887, when the same number of furnaces was reported as in blast, but the reported capacity was but 86,709 tons."

Electro-Magnetic Machine Tools.—The first successful examples of electric machine tools are the electro-magnetic machines introduced by Mr. John McMillan, Sr., into the practical work of his shipyard, at Dumbarton, Scotland, from which, on May 19, 1887, was launched the screw steamer *Albania*, having a portion of the rivet holes in her shell drilled by these machines. After a very small amount of practice, the men working the machines drilled the ⅞-in. holes in the shell with great rapidity, doing the work at the rate of one hole every 69 seconds, inclusive of the time occupied in altering the position of the machines by means of differential pulley-blocks, which were not conveniently arranged as slings for this purpose. Repeated trials of these drilling machines have also shown that, when using electrical energy in both holding-on magnets and motor amounting to about ¾ H. P., machines have drilled holes of 1 in. diameter through 1½ in. thickness of solid wrought-iron, or through 1⅝ in. of mild steel in two plates of $\frac{13}{16}$ in. each, taking exactly 1¾ minutes for each hole. Another machine, which has magnets of less holding power, when using only about 0.6 H. P. of electrical energy, took the same time to drill holes of $\frac{11}{16}$ in. diameter through wrought-iron of $\frac{13}{16}$ in. thickness. As regards speed of drilling, it is believed that these results are equal to any obtained by machines using much greater power. With a hammer using an electro-motor giving out one half brake H. P., from 100 to 150 blows per minute have been obtained, with a force of impact equal to about 180 foot-pounds per blow, as nearly as could be ascertained. This is much greater than the force of blow given by hand hammers weighing 6 pounds and striking as heavily as is possible in staving up. At the works of Messrs. Immisch & Co., in March last, this riveter was seen closing 1-in. rivets in 10 seconds each. The electro-motors used in the machines constructed for Mr. McMillan, with which these results have been obtained, were of Messrs. Immisch's design and manufacture. After seeing the machines at work in Messrs. McMillan's yard, Messrs. William Denny & Brothers constructed an electrical drilling machine having a modification of the traversing frame, but without holding-on magnets, and applied this machine to drilling the rivet holes in the butt joints of a large steamer.

Domestic Motive Power by Atmospheric Exhaustion.—M. A. Tesca, in the *Bulletin de la Société d'Encouragement*, says that the Society for the Distribution of Power in Dwelling Houses has established a system of domestic motive-power in the Rue Beaubourg, one of the most populous districts in Paris, supplying power in small quantities to work the tools or machines employed in small industries. M. Petit, the inventor, assisted by M. Boudenot, erected at first a powerful steam-engine of 75 H. P., with a boiler, which was employed to work a large air-pump, placed behind the steam-cylinder for the purpose of exhausting the air from an underground conduit into the atmosphere. From this main conduit, placed for the most part in the sewers, small pipes or tubes were branched into the blocks of houses, ending in rising columns, analogous to those employed for the distribution of gas in the interior of houses.

The vacuum thus maintained in the main conduit and its branches, serves to drive the small motors erected in each work-room, by the rush of the air of the rooms through the motors into the pipes, after having acted by its pressure on the pistons of the machines. Whatever the number of open branches, that is to say, of little motors in action, the vacuum is maintained in the conduit, supposing, of course, that the duty of the air-pump is equal to the volume of external air entering the conduit from the various branches. For this purpose, the vacuum-gauge is provided with alarms to announce excess of pressure or of vacuum, as the case may be. Uniformity of pressure can be easily maintained by the attendant; and thus it is that, whilst the engine may work slowly at certain hours of the day, it may work at double the speed when the demand for power is augmented. Each motor is fitted with a meter, by which the consumption is correctly gauged.

The installation in the Rue Beaubourg commenced operations in January, 1885; and May, 1886, the power was entirely utilized in driving 70 small motors, in as many workshops, of a power of from 40 foot-pounds to 290 foot-pounds, on a length of about 5,000 ft. of passage-way in the Rue Beaubourg and the adjoining streets.

The new exhausting steam engines and pumps are in course of erection alongside the first one, and the complete installation will consist of 3 exhausting steam engines and pumps of 75 H. P. each, or together 225 H. P.; 2 steam-boilers; a system of passage-ways 6,600 ft. long, and about 200 small motors on the different floors of a block, or separately in the different houses of the quarter.

A Petroleum Tank Steamer.—We recently noticed the launch from the Low Walker ship-building yard of Messrs. Sir W. G. Armstrong, Mitchell & Co., of the steamer *Ville de Calais*, which has been specially built for the carriage of crude petroleum in bulk, and which is, we believe, the first steamer of the kind that has ever been specially constructed for this purpose. The *Ville de Calais* is built of steel to the highest class Veritas, and is capable of carrying 2,400 tons dead weight, on less than 18 ft. draft. She is subdivided by a longitudinal and athwartship bulkhead into numerous cells or compartments, each of which has its own expansion chamber, which latter also forms a receptacle for the gases which are evolved from the cargo. These arrangements in this vessel are of a very special description—petroleum in its crude state being much more volatile than refined; for this reason, also, the general construction and workmanship of the hull had to be treated more like boiler-work than ordinary ship-building; and before launching, each compartment was tested with water, having a head pressure considerably in excess of what would be sustained in ordinary working. There is a very complete installation of pumps on the Worthington system, both for discharging the cargo and equalizing at will the amount of oil contained in the various compartments. The machinery is on the triple-expansion system, by the Wallsend Slipway & Engineering Company, and during her trial on Thursday last worked with perfect smoothness and without the slightest hitch. The vessel was fully laden with water to the contract draft, and obtained a speed of 10 knots. On Saturday, she sailed to Calais, where she has since arrived, all well, after a

good run. The whole of the vessel's arrangements are of the most complete description, including a full electric-light installation by Messrs. Clarke, Chapman, Parsons & Co. Sir W. G. Armstrong, Mitchell & Co. have given the construction of petroleum steamers their special attention, and the *Ville de Calais* is the third tank steamer delivered by them this year, the previous vessels being the *Minister Maybach* of 3,300 tons d. w., and the *Hans und Kurt* of 2,800 tons d. w.; whilst a fourth, named the *Willkommen* of 4,000 tons d. w., will take her trial trip this week; and the same builders have yet another vessel in hand in an early stage of construction.—*The London Engineer.*

The Best Way of Destroying a Railroad.—A knowledge of the art of building railroads is certainly of more value to a country than that of the best means of destroying them; but at this particular time the destruction seemed necessary, and the time may again come when such work will be necessary. Lest the most effectual and expeditious method of destroying railroad tracks should become one of the lost arts, I will here give a few rules for the guidance of officers who may in future be charged with this important duty. It should be remembered that these rules are the result of long experience and close observation. A detail of men to do the work should be made on the evening before operations are to commence. The number to be detailed being, of course, dependent upon the amount of work to be done, I estimate that 1,000 men can easily destroy about 5 miles of track per day, and do it thoroughly. * * * * Your detail should be divided into three sections of about equal numbers. I will suppose the detail to consist of 3,000 men. The first thing to be done is to reverse the relative positions of the ties and iron rails, placing the ties up and the rails under them. To do this, Section No. 1, consisting of 1,000 men, is distributed along one side of the track, one man at the end of each tie. At a given signal each man seizes a tie, lifts it gently till it assumes a vertical position, and then at another signal pushes it forward so that when it falls the ties will be over the rails. Then each man loosens his tie from the rail. This done, Section No. 1 moves forward to another portion of the road, and Section No. 2 advances and is distributed along the portion of the road recently occupied by Section No. 1. The duty of the second section is to collect the ties, place them in piles of about 30 ties each—place the rails on top of these piles, the center of each rail being over the center of the pile, and then set fire to the ties. Section No. 2 then follows No. 1. As soon as the rails are sufficiently heated, Section No. 3 takes the place of No. 2, and upon this devolves the most important duty, viz., the effectual destruction of the rail. This section should be in command of an efficient officer, who will see that the work is not slighted. Unless closely watched, soldiers will content themselves with simply bending the rails around trees. This should never be permitted. A rail which is simply bent can easily be restored to its original shape. No rail should be regarded as properly treated till it has assumed the shape of a doughnut; it must not only be bent but twisted. To do the twisting, Poe's railroad hooks are necessary, for it has been found that the soldiers will not seize the hot iron bare-handed. This, however, is the only thing looking toward the destruction of property which I ever knew a man in Sherman's army to decline doing. With Poe's hooks a double twist can be given to a rail which precludes all hope of restoring it to its former shape except by re-casting.—*General H. W. Slocum, in the Century for October.*

Coal and Petroleum in the Argentine Republic.—Consul E. L. Baker writes to the State Department from Buenos Ayres: "The question of coal deposits in the Argentine Republic, about which there has, in the past, been so much doubt and uncertainty, is gradually approaching an affirmative solution. In my last annual report I referred to the discoveries made by Colonel Oloscoago, in the southern portion of the province of Mendoza; as also the discoveries announced by an American miner in the province of San Juan. We now have information that 'coal of first-class quality and abundant' has been discovered at two different points, one 40 leagues and the other 50 leagues south of San Rafael, a small town in the province of Mendoza. Likewise, Prof. L. Brackenbush, of the University of Cordoba, who has been making scientific researches on the estate of Sr. Igarzabal, near Paganso, in the province of Rioja, announces to the public that 'coal is there, rich and abundant, and only 30 kilometers from the Colorados Railway station on the Chilceto & Dear-Funes Railway line.' A plan of the deposits has been drawn up with a view to their exploration. So I suppose the conundrum of coal or no coal may now be considered as fully answered in the affirmative.

"I may add here, that a company has lately been formed in this city for working the petroleum deposits, heretofore announced by me to have been discovered near the city of Mendoza. We now have intelligence that at a depth of 120 meters the deposit was reached, and that a steady steam of pure petroleum comes to the surface. The news has caused some stir here, in view of the great and constant demand all over the Argentine Republic for kerosene oil, the bulk of which now comes from the United States. Owing, however, to the distance from the River Plate at which this Argentine petroleum is found, and the expense of transportation, I doubt if it will be able to compete in price with the American article, unless the Argentine Government puts on a prohibitive tariff."

Railroads in the Argentine Republic.—Consul E. L. Baker, at Buenos Ayres, in his annual report to the State Department for 1880, says: "The work of railroad construction has been prosecuted with more than usual activity during the past year.

"The extension of the Central-Northern road is now completed a distance of 270 kilometers beyond Tucuman, and most of the work is ready for the superstructure as far as Salta. One hundred kilometers of road have likewise been completed between Rosario de la Frontera and Metan. The work between Chilcas and the Rio Passagè is in progress, and the whole line will be pushed during the coming year, as also the branch from Dear-Funes to Chilceto, a distance of 415 kilometers.

"All the accessory works of the branch of the Northern Central to Santiago del Estero have been finished, and also of the branch to Chumbicha, 176 kilometers, and both lines have been opened to the public sarvice.

"The road from Buenos Ayres to Rosario, a distance of 305 kilometers, finished at the date of my last annual report, has been running regularly during the last year, thus reducing the time between the two places to seven hours. It is now being extended on to Sunchales, 45 kilometers, and will soon be completed to that point.

"A second road, projected in the interest of the Buenos Ayres & Pacific road, is now under construction from here to Mercedes, in this province, where it is to connect with the said Pacific road, now completed as far as Mercedes, in the province of San Luis, a distance of 336 kilometers. It is now being further pushed on to Orellanos, 355 kilometers, to which place it will be finished in a few months. From Mendoza, westward, the last link in the Andine road is now under contract.

"Various other roads have been projected, and for some of these concessions have been obtained from the Government; among these is a railway from Bahia Blanca directly across the Andes by a new pass to Chili, and another from Buenos Ayres also across the Andes to Chili by a southern pass.

"As showing the progress which railroad construction has been making in the Argentine Republic, I may say that in October, 1880, the total number of kilometers was 2,318, of which 810 belonged to the National Government, 348 to the Provincial Government of Buenos Ayres, and 1,104 were in private hands. There are now 6,152 kilometers in the Republic, of which 1,877 belong to the Nation, 1,104 to the Provincial Governments and 3,161 to private companies; a gain of about 3,834 kilometers in a little over five years."

New York Harbor Improvements.—Lieutenant-Colonel Walter McFarland, U. S. Engineers, has submitted to the War Department his annual report upon the work of improvement of New York Harbor. The report states that the survey of Gedney's Channel, finished on June 21, showed that the channel has maintained the increased depth which it had received, and leads to the belief that the still greater depth which the act of Congress calls for may be equally maintained when once secured.

All the work of improving Gedney's Channel and the main ship channel is now in the hands of one firm, and the indications are that the work of deepening Gedney's Channel will be finished this year. The dredges will then be set at work on the main ship channel, the deepening of which is to be finished by December 1, 1888. Under the present agreements, 700,000 cubic yards of material will be removed from Gedney's Channel and 1,500,000 from the ship channel. This is said to be not much more than one-half the amount of material that must be removed in order to secure a depth of 30 ft. at mean low water, with a width of 1,000 ft., and the removal of the remainder will cost $540,000. Colonel McFarland makes an earnest protest against the injury now being inflicted on the harbor by dumping into it the dredgings of the docks and slips and ashes and cinders from steam vessels, and instances cases where lumps and shoals have been formed in this way.

The sum available on July 1 for the improvement of New York Harbor was $742,293, and the amount that can be profitably expended during the next fiscal year is $540,000, unless

it should become necessary to resort to contraction works, which would cost between $4,000,000 and $5,000,000.

In the River and Harbor bill of August, 1886, an appropriation of $112,500 was made for continuing the work at Hell Gate. The amount was too small to admit of working the drill-scow on the small reefs and continuing work on Flood Rock at the same time, and it was determined to apply it entirely to the latter purpose by increasing the wid h of the new middle channel by dredging a cut along its easterly margin to the full depth of 26 ft. Work was begun with two machines in November and continued until April 15, after which time one machine only was used, working night and day.

The latter method of working has not, however, given as good results as working two machines by daylight only, the progress having fallen from 113 tons per machine per day of 12 hours to 59 tons. This decline in the rate of progress is partly to be attributed to the accumulation on the reef, after it has been worked over a considerable time, of fine material which is too small to remain in the grapple while it is being hoisted through the swift current. It has not been thought practicable, however, to use an ordinary dredging bucket to pick up this material, because scattered through it are occasional large masses which would soon destroy the bucket. The total amount of material removed during the fiscal year was 34,956 tons, leaving about 230,000 tons yet to be removed.

The amount that can be profitably expended in the removal of obstructions in the East River and Hell Gate during the next fiscal year is $500,000, to be applied chiefly to the removal of Flood Rock and to continuing operations with the steam drill scow on other obstructions.

Well-Water.—The great majority of the people in this country obtain their drinking water from the moving sheet of water which lies at a greater or less depth beneath the surface of the earth, and for this purpose they use wells.

The questions as to how far, and under what circumstances, well-water may be dangerously contaminated, and how such contamination may be best recognized when present, or be foreseen and guarded against, are therefore of constant interest. The *Journal* of the Chemical Society for June of this year, contains a paper by Robert Warrington, entitled "A Contribution to the Study of Well-Water," which is of more than ordinary value and interest. In this paper are given the results of a continuous and systematic examination of the well-waters of Rothampsted, England, and of the connection between the composition of rain, drainage and deep-well waters. Taking a series of observations for several years it was found that the rain contained, in a million parts, an average of two parts of chlorine, 0.67 part of combined nitrogen, and 2.52 parts of sulphuric acid. By drainage through 5 ft. of bare soil the quantity of chlorine is not increased, but the combined nitrogen is increased about nine times by oxidation of the organic matter in the soil. The production of nitrates occurs chiefly in the summer months, and the first considerable drainage which occurs after summer will contain the greatest proportion of the nitrates.

Nitrates being assimilated by plants are generally absent in drainage from land bearing an actively growing crop. The proportion of chlorine in the purest wells at Harpenden is about 11 per million, and it varies very little. Wells in soil much contaminated by sewage may show the commencement of a rise in the chlorides one or two months after the active autumn drainage begins, and two months before the water-level in the well begins to rise. Wells little liable to contamination show a rise in chlorides later in the season. When soil has been long contaminated by sewage, and then fresh contamination ceases for a number of years, the proportion of chlorides in the well-water may be considerably higher than normal, but it will remain nearly unaltered through the drainage season.

In contaminated well waters the proportion of nitrates and chlorides increases at first at an equal rate, but if active drainage continues the proportion of nitrates greatly increases. The sewage of a poorly-fed population gives a high proportion of chlorides to nitrates, while stable sewage eauses the reverse. The chloride contamination is more permanent than that by nitrates. The probable average proportion of nitrogen as nitrates in drainage water from cultivated land is 3.8 per million.

The examinations of waters made by Mr. Warrington were almost entirely chemical; the only exception was a series of experiments which indicated that a nitrifying micro-organism is contained in deep-well waters, but in very small proportions.—*Sanitary Engineer.*

Cotton Cultivation in Russia.—Minister Lothrop writes to the State Department as follows: "The Imperial Government is making very strenuous and persistent efforts to promote the cultivation of cotton within its own dominions, with the hope to carry the home production to the point of excluding all foreign-grown cotton.

"An article in a late number of the *Journal* of St. Petersburg, compiled from the Moscow *Gazette*, may be found interesting in this connection.

"It has recalled to me a conversation I had this spring with Lieutenant-General Annenkoff, the able and enterprising soldier who has charge of the construction of the Trans-Caspian Railroad. He assured me that he should open the line to Samarcand on November 15 next, and gave me an invitation to attend the formal opening on that day. He said that, within one year, he should be able to deliver Central Asia cotton in Moscow at one-half of the present price of cotton there.

"You will notice that an increase of the duty on cotton is suggested, and as that falls in with the ruling policy, it is very probable that it will be done.

"The *Journal* supposes that in Central Asia, and also in the Trans-Caucasus, the conditions for cotton culture are essentially the same as in the United States. But this is probably not quite accurate.

"As I am informed, in most places irrigation will be necessary. And it will be long before the native cultivators can be inspired with American skill and enterprise. At present, the native cotton is said to be inferior in the strength and length of its fiber. This may be overcome by the introduction of new varieties. The Government has already brought seed and experts in planting from America. It has recently been stated that there was already a considerable cotton plantation near Merv, owned and operated by Americans; but this was afterward denied, and it was added that a concession of land for that purpose had been refused to a company of Americans. I do not know what the fact is."

The article from the *Journal* of St. Petersburg, above referred to, says: "To free our manufacturers from their dependence upon the producers of the other side of the water, and to avoid the obligation of paying dear for a product which could be cultivated in Russia, it is only necessary to encourage its cultivation. That would not, says our cotemporary, be so difficult as one would think, for all the essential conditions for cotton cultivation are united in the south of Russia. The Trans-Caucasian country, as well as our possessions in Central Asia, differ in no way as to climate from the United States.

"The proof of this is that the best kinds of American cotton are cultivated there with success, and considerable progress has already been made, in spite of the little care given by us to cotton. Thus, only six years ago, but 21 poods of American cotton were exported from Taschkend, whereas last year over 25,000 were gathered.

"In the province of Erivan, where a few years since this cultivation was in its infancy, it is now assuming the appearance of a real industry. These examples prove sufficiently that cotton could be cultivated with us on a great scale. Only a little more energy is required and the capital necessary for so vast an enterprise. Without help from the State no result could be reached, because, independently of the necessary works for irrigation of the plantations, the installation of which would be very costly, it is indispensable that a credit should be opened to the planters sufficiently large for their first wants, and notably for the purchase of seed of good quality.

"The objections to this project, which would have for basis the impossibility of weighing down the budget with a new expense, are groundless. Without creating new articles of expenditure, the cotton industry itself might be made to pay for the creation and improvement of this branch of agriculture."

The imports of cotton into Russia over the European frontier in 1886 were 7,247,651 poods, or about 53,100 bales of 500 lbs. each.

Tramways in France.—At the beginning of the present year there were 436¼ miles of tramway or street railroad in operation in France, an increase of 5½ miles over the preceding year. The total amount of capital invested in the various lines is about $27,000,000, or a little over $60,000 a mile. Of this sum, about 45 per cent. was represented by permanent way and 55 per cent. by equipment and working stock. The traffic receipts in 1886 were, in round figures, $7,075,000; the working expenses, $5,820,000, and the net earnings $1,255,000. The net earnings were thus about 4.65 per cent. on capital invested. The returns varied greatly in different cities, however, the lines in Bordeaux having paid 30 per cent.; in Havre 13, and in Lyons 9 per cent., while in several of the smaller cities the working expenses exceeded the traffic receipts. The five companies owning the Paris lines returned net earnings amounting to an average of 3.54 per cent. on capital.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT NO. 45 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid..............$3 00
Subscription, per annum, Foreign Countries........ 3 50
Single copies.. 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

MR. J. HOWARD BARNARD, 7 Montgomery Avenue, San Francisco, Cal., is the authorized Western Agent for the JOURNAL.

MR. FREDERIC ALGAR, Nos. 11 and 12 Clements Lane, Lombard Street, London, E. C., England, is the authorized European Agent for the JOURNAL.

NEW YORK, DECEMBER, 1887.

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THE Spanish cruiser *Reina Regente*, an engraving of which will be found on another page, has developed extraordinary speed, having run at the rate of over 20 knots an hour on the measured course in fairly smooth water. This is, of course, a greater speed than could be maintained for long distances or at sea, but it shows sufficiently that the ship is capable of making very fast time under any ordinary circumstances.

Two or three of the new cruisers now under contract for our own Navy are required by the specifications to make 19 knots an hour. If they can do this, and there is no doubt that the contract can be carried out, they will rank with the *Reina Regente* and a few others as the fastest warships afloat. The advantages of speed in a cruiser are too many and are too evident to need recapitulation here, and the possession of even a few such vessels would be of very great advantage in case of war.

Very few people realize how few vessels there are which can make the time indicated by these figures. It does not seem an extraordinary statement to say that a steamer can make 19 knots an hour; but 19 knots is very nearly 22 statute miles, or ordinary railroad speed. Very few even of the fastest trans-Atlantic steamers can do better than this, or even as well; and we cannot recall more than three or four existing warships which can come up to it.

LIKE the new Spanish cruiser, the Spanish torpedo-boats illustrated and described elsewhere have shown extraordinary speed and are almost, if not quite, the fastest vessels afloat. There is, however, a material difference between them and the cruiser. The torpedo-boat is a machine in which almost everything else is sacrificed to obtain great speed. It is not designed for long runs, and is not expected to keep up its extraordinary pace for any great distance, and accordingly has no great capacity for fuel or stores and but scanty provision for comfort of crew or officers. In a word the torpedo-boat is simply an enlargement of the floating or submarine torpedo, and is rather a marine projectile than a cruising vessel. That it must be fast is a necessity, and everything else is subordinate to this consideration.

IN his annual report to the Secretary of the Navy, Admiral Porter advocates strongly some plan which may secure the building of merchant vessels of a class which could be readily converted into naval cruisers in case of need. The Admiral takes very much the same ground on this point as was assumed in a recent article in this column, and enforces his conclusions by a reference to foreign experience.

AN important change in the method of charging for the use of freight cars on foreign lines has been adopted by the Pennsylvania and several other leading companies, and seems to be in a fair way to come into general use. Heretofore the settlements between the companies have been made entirely on the basis of the mileage traveled by a car, the usual rate for some years past having been three-quarters of a cent per mile. This plan has the defects that under it a car earns nothing unless it is in motion, and also that a company has no inducement to hasten the return of a car belonging to another line, but can hold it in a yard or at a way station as long as it pleases without incurring extra charges.

Under the new system a mixed charge of one-half cent a mile and 15 cents a day is substituted for the simple charge of three-quarters of a cent per mile. By this arrangement a car which is side-tracked will at least be earning the 15 cents a day for its owner, and this time charge, which will rise in the aggregate to a considerable amount for companies handling many foreign cars, will be a substantial inducement to hasten the loading and unloading of cars and their return to their owners.

A subordinate feature of the change is that the *per diem* rate will be charged on cars sent to shop for repairs and on cars destroyed until date of notice to owners, thus enforcing the necessity of prompt notification in the case of cars damaged or destroyed, a matter now too often neglected.

The new system has been urged on the railroads by the Car Accountants' Association, a body which has been very active in its department, and has done much creditable work. It is to be hoped that it will result in fulfilling the expectations entertained of it, and will put a stop to the many delays now encountered in moving freight cars.

THE latest addition to Panama Canal literature is a report from Señor N. T. Armero, the Agent of the Colombian Government in its dealings with the Canal Company. Señor Armero is inclined to hope that the skill of the managers of the company, backed by French national pride, will secure the completion of the canal hereafter. The facts which he presents in his report, however, corroborate fully the discouraging accounts heretofore published. He says that only about one-fifth of the estimated amount of excavation of the canal has been done, and that on the easier portions of the work, and points out that the two most difficult and expensive portions of the work—the excavation of the Culebra section and the diversion of the Chagres River—have barely been touched yet. He believes further that the amount of money still needed is nearly four times that already spent, and his estimate brings the cost of the canal almost up to $800,000,000. He asserts also, as the result of his observations, that the number of men employed by the company has never been as great as claimed, and that now many sections of the work are almost deserted.

M. de Lesseps has recently announced that the canal is to be opened by February, 1890, but says that it will not then be entirely completed, although sufficiently far advanced to permit the passage of vessels. This announcement is probably meant to encourage French investors in the securities of the Canal Company; it does not seem to be seriously received anywhere by those who have any knowledge of the real condition of things on the Isthmus.

AN increase in the speed of trans-continental trains has been made on the Union and Northern Pacific routes, the gain on the Union Pacific being 15½ hours, of which 10 hours is made between Omaha and Ogden, on the Union Pacific's own line, and 5½ hours between Ogden and San Francisco, on the Central Pacific road. The gain on the Northern Pacific by the new fast train is 18¾ hours between St. Paul and Portland. The Southern Pacific and the Atlantic & Pacific lines make no change.

The Pacific railroad lines have never made any special attempt to secure fast time on their regular trains. By the schedule lately in force the Northern Pacific express trains took about 91 hours to run the 1,913 miles from St. Paul to Portland, giving an average of about 21 miles an hour, without allowing for stops. By the Union Pacific route trains took 86½ hours to run 1,866 miles, giving an average speed of 21½ miles, also without allowing for stops.

The new schedules, making the time 71 hours on either line, will give average runs of 27 miles an hour by the Northern and 26¼ miles by the Union-Central Pacific route. Even after making the necessary allowance for stops, this will not require any very fast running.

HEATING cars by steam from the locomotive is to be tried to a considerable extent this winter, and there is no doubt that before spring we shall have a very fair idea of its merits and defects in actual practice. The New York Central & Hudson River Company will soon have a number of its local trains equipped and will probably extend the application of the system. The Pennsylvania Railroad, it is understood, is preparing to do a good deal of work in the same direction, and other companies are following. Several of the systems of continuous heating have met with favor and will be put into service quite extensively, and there will probably be an active discussion of their respective merits, even after a term of service has tried them.

The adoption of steam heating, indeed, seems likely to be so general that several important companies have thought it well to consult as to the question of adopting uniform couplings for the steam-pipes in the cars. This is a question of considerable importance and well deserves attention now, when it will be comparatively easy to secure uniformity, and so avoid the many troubles and annoyances which will be sure to arise later. There are several systems of continuous heating which seem to possess merit, and it is not likely that any one of them will secure general adoption to the exclusion of all the others, but there should be no great difficulties in the way of adopting at least a uniform coupling now. At any rate the obstacles to such action are necessarily less formidable at present, than they would be by-and-by, when a large number of cars may be equipped with different patterns, requiring a considerable expenditure to make changes.

THE much vexed question of the increase of terminal facilities of the Brooklyn Bridge is to be referred to a new commission of experts, who are to consider the plans already submitted to the Bridge Trustees. The need of greater facilities for the reception and discharge of passengers on the Bridge railroad is a pressing one, and some measures of relief should be adopted as soon as possible.

The question is not an easy one to solve, combining the conditions of a necessarily limited space, an enormous traffic compressed within a few hours of the day and the consequent need of an almost continuous movement of trains with the least possible waste of time in loading, unloading and shifting, and finally the necessity of avoiding all possibility of accident. There is no precedent by which to go, for even the New York elevated railroads have more room to turn their trains, do not require to turn them so frequently and have at least the advantage of independent motors, whose number can be increased, while the Bridge traffic is subject to the limitations of the cable system.

There has been some difficulty in getting experts who are qualified to serve on the commission, chiefly because their number is limited and their time very fully occupied. The commission as finally made made up, however, is a very capable and satisfactory one; it consists of Colonel Julius W. Adams, of Brooklyn; Mr. Joseph Crawford, Superintendent of the New York Division of the Pennsylvania Railroad, and Mr. Walter Katte, Chief Engineer of the New York Central & Hudson River Railroad.

A BRIDGE over the Hudson River at New York is an idea which has doubtless occurred to many, only to be dismissed as impracticable. Such a structure is now seriously proposed, however, the leading projectors being T. A. Potts, of the New York, Susquehanna & Western Railroad, and Bird W. Spencer. Their plan is for a structure on the cantilever system, with a central span of 725 ft., to be high enough above the water to permit the passage of the largest vessels. The proposed place is from Stevens' Point, just above Hoboken, to a point in the city near Forty-second Street.

The project at present is in its earliest stages and can

hardly be said to have even taken definite form. It must pass through a long stage of discussion before it reaches a point where it is to be regarded even as a probability, and it does not appear likely that the actual construction of a bridge will be began for a long time yet. Certainly such a structure would be desirable, but there are so many difficulties in the way that it is not easy now to see how they can be overcome.

THE election of Professor Samuel P. Langley to the important post of Secretary of the Smithsonian Institute was generally expected. Professor Langley has been for some time Assistant Secretary and has discharged the duties of the office since the late Professor Baird was compelled by his failing health to give up the work.

The new Secretary is in the prime of life and has a high reputation as a scientist, based upon valuable researches, chiefly in the department of solar physics. He has also shown much ability as an organizer and director while in charge of the Allegheny Observatory and elsewhere. His ability has been generally recognized both in this country and abroad.

SPECIFICATIONS FOR CAST-IRON CAR WHEELS.

DURING the session of the last convention of the Master Car-Builders' Association, a meeting of car-wheel manufacturers was held at the same time and place. One of the objects of this meeting, it was said, was "to consider how to give railroad companies the best wheels for the least money." The wheel-makers appeared before the Master Car-Builders' Association with Mr. Whitney, of Philadelphia, as their spokesman, who asked that a committee be appointed by the Master Car-Builders to confer with the wheel-makers, and said that the Master Mechanics', and perhaps some other railroad associations, would be requested to do the same thing, and that these committees, with the wheel-makers, would form a joint committee to consider the whole question of the use of wheels, the guaranteeing of the mileage, and the defects of wheels which result from usage, and defects that are due to the manufacture.

The Master Car-Builders' Association appointed such a committee, and no doubt some action—such as is outlined above—will be taken before the next convention.

There can be no doubt of the fact that good cast-iron wheels are very safe and reliable, and will very seldom fail by breaking. On the other hand, it is equally certain that large numbers of the wheels which are made and put into service do break and cause accidents more or less serious. It is, therefore, of the utmost importance that wheels should be subjected to inspection and tests, which will determine whether they are good or bad, and that when wheels are bought, the tests to which they will be subjected and must conform should be specified. No doubt the very excellent committee which has been appointed will be able, in consultation with the wheel manufacturers, to prepare specifications which will insure that wheels made in conformity therewith will be reliable. Probably, too, if those who will consider this subject will formulate their knowledge of wheel manufacture, and their experience in their use, into the shape of complete specifications, it would result in railroad companies getting better wheels than ever before. The Joint Committee, therefore, has a very important duty to perform, and if they do what from their knowledge and experience of the subject may not unreasonably be expected of them, their action ought to be instrumental in preventing many accidents and do a great deal to make travel and traffic on railroads safer and surer.

But it will be six months before the next annual convention of the Master Car-Builders' Association meets, and before any action can be taken on the Committee's report. In the meanwhile railroad companies must use and order wheels. It is essential that many of them should do something at once to improve the quality of the wheels they are buying. If they can do nothing better, such companies would do well to adopt the specifications of the Pennsylvania Railroad, which are printed on another page, until the Joint Committee referred to makes its report and the Master Car-Builders' Association takes action on it.

But it does not matter what specifications are adopted, the mere *adoption* of them will do little good, if those who buy the wheels do not take steps to secure conformity to the requirements of the specifications. This means that some system of testing and inspection must be adopted to determine whether wheels furnished are up to the requirements. To use a Hibernian expression, "to say this is easy but to do it?" There are always influences in and about a railroad company which somehow or other seem naturally to array themselves against any faithful and honest system of testing. If an officer of a railroad company, who is the inspector or the inspector's boss, owns stock in the foundry which furnishes the wheels, his judgment and impartiality are apt to be perverted. If the inspector is amenable to the influence of gifts and bribes, in time he will become judicially and morally color-blind, so to speak. Unfortunately, too, there are no kinds of yarns or worsteds or cards—unless it be the kind used in playing whist—by which this defect in moral vision can be tested. If a director owns an interest in a furnace which makes wheel-iron, his influence may be directly exerted to have wheels made of that iron accepted. The purchasing agent may belong to that class whose only training has been in "the school of swop," and whose chief aim it is to show to the Board of Directors how little he pays for what he buys, and who, therefore, gives little or no attention to any other question excepting low-pricedness, to coin a word for the occasion. The master car-builder may be one of the kind of people "who know-it-all," and who prides himself of being practical and assumes for himself a kind of prescience, which may dispense with the adventitious aid of science or experiment and will have none of the nonsense of "them literary fellows." The wheel-maker, when wheels will not stand the prescribed test, may have friends within or without the circle of the railroad's officers, and may have impressed some of them that this testing business is all nonsense, and they bring the weight of their influence to bear against it. A lot of wheels is needed in a hurry, there is not time to test them, so they are put into service without. The testing department costs several thousand dollars a year, and the engineer in charge is paid more than some director or committeeman thinks he is worth; so his salary is reduced, and an ignorant person is put in his place—the department is badly managed and finally the whole system is swept away to "economize." In this and other ways the inspecting department falls into disrepute.

A structure of any kind, if left to itself, immediately begins to deteriorate; moth and rust are as active to-day as they were in biblical times, and decay begins when supervision ends. This is especially true of a system of inspection. The elements by which it is surrounded seem to have a destructive affinity for the material of which it is composed, and, if not constantly guarded and protected with intelligent care, decomposition will be the result.

The Master Car-Builders' Association will no doubt adopt specifications for car-wheels, but this, without inspection, will not be sufficient.

NEW PUBLICATIONS.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT, FOR 1887. Washington; Government Printing Office.

The annual report of the Chief Engineer of the Navy contains much interesting matter, and shows that the present head of the Bureau of Steam Engineering appreciates the extent of the work to be done in this department. In times past much good work has been done by this Bureau in an experimental way, and Mr. Melville now urges a continuance of this work in the direction of the use of forced draft and high steam pressures, with triple and quadruple-expansion engines. Something has already been done in this line, and more is expected as the new ships and engines now under construction come into use.

As a necessary corollary to the advances in marine engineering already made and in progress, the report urges the advantages of still further specializing the engineer corps of the Navy and making its officers and working force still more distinct from the line. This brings up a wide question, which, it may be said, is now agitating almost every navy in the world. The modern warship is so complex a machine and so much dependent upon its engineer force, that it is no longer possible to keep that force in the very subordinate and inferior position which it occupied when steam vessels first came into use. In every country, however, the naval officers proper—the fighting men—have been reluctant to admit this, and have, as a rule, resisted all attempts to place their engineer coadjutors on an equality with themselves. It is only for the reason that the fighting ship nowadays is helpless without its engineers that they have been able to force even a partial recognition of their claims.

The report makes the excellent recommendation that engineers be attached to the staff of each flagship for inspection duty. It also urges the expediency of special details of engineers to study foreign practice and watch the improvements and experiments in marine engineering in progress in Europe.

BOOKS RECEIVED.

THE RAILROAD AS AN ELEMENT IN EDUCATION: BY PROFESSOR ALEXANDER HOGG, M. A. Louisville, Ky.; printed for the Author. This is a reprint of an address delivered before the International Congress of Educators, at the New Orleans Exposition, by Professor Hogg, who is Superintendent of Public Schools at Fort Worth, Texas.

THE STEAM ENGINE CATECHISM: BY ROBERT GRIMSHAW, M. E. New York; John Wiley & Sons (Price $1.00).

NATURAL LAW IN THE BUSINESS WORLD: BY HENRY WOOD. Boston; Lee & Shepard, and New York; Charles T. Dillingham.

JOY'S VALVE GEAR. London; issued by David Joy. This little pamphlet is mainly composed of a list of steamships, stationary engines and locomotives to which Joy's valve gear has been applied.

CANADA. STATISTICAL ABSTRACT AND RECORD FOR THE YEAR 1886: COMPILED BY SIDNEY C. D. ROPER. Ottawa, Canada; published by the Department of Agriculture. This is a valuable abstract of statistical information—geographical, agricultural, commercial, historical, etc.—concerning the Dominion of Canada.

NEWTON MACHINE TOOL WORKS: CATALOGUE. Philadelphia, 24th and Wood Streets; Charles C. Newton, Engineer and Proprietor.

The Westinghouse Brake Trials.

THE Westinghouse Brake Company has been for some time making a series of tests with a train of 50 freight cars equipped with its brake. One of these tests was made on the West Shore road at Ridgefield Park, N. J., November 21, with the following results, the train consisting of 50 cars:

	Miles per hour.	Distance, feet.	Time, seconds.
Emergency stop	22	203	12½
" "	41	674	20
" "	41	672½	20
Hand-brake stop	21	2,137	85

A "breakaway" test was then made, and the two sections of the train were stopped when 43 ft. apart.

The following test was made with a train of 20 empty cars, fitted with the freight brake, but with increased leverage for passenger service: Emergency stop at 22 miles an hour; made in 91 ft. and 6 seconds.

Another test was made with the same train and a train of West Shore passenger cars, running on parallel tracks, the brake being applied to both trains when the engines were abreast and running at the same speed:

	Speed, miles.	Distance, feet.	Time, seconds.
Freight	45	495	13½
Passenger	45	1,204	27

The tests have excited much interest, and the one in question was witnessed by a large number of railroad men.

The Pennsylvania Railroad Company's Specifications for Cast-Iron Car-Wheels and Car-Wheel Iron.

GRADING PIG-IRON FOR CAR-WHEELS BY CHILL TESTS MADE AT THE FURNACE.

THE chill cup (one of which we furnish) is to be filled *even full* at about the middle of every cast from the furnace by using a small ladle, or by placing the cup in the pig bed, a little below the level of the pigs, and letting the iron flow into it until it is *even full*. The test piece so made will be 7½ in. long, 3½ in. wide, and 1¾ in. thick, and is to be broken across the center when entirely cold. The depth of chill will be shown on the *bottom* of the test piece, and is to be measured by the *clean white portion to the point where gray specks begin to show in the white.* The grades are to be by eighths of an inch, viz.: ⅛, ¼, ⅜, ½, ⅝, ¾, ⅞, etc., until the iron is mottled; the lowest grade being ⅛ in. in depth of chill. The pigs of each cast are to be marked with the depth of chill shown by its test piece, and each grade is to be kept by itself at the furnace and in forwarding. At large anthracite and coke furnaces it is best to take three test pieces of each cast, viz.: at the beginning, middle and end, and if there is a difference of ⅛ in. or more in depth of chill between the first and last of the cast, the pigs should be divided into

two or three portions, and graded by their respective chill tests.

SPECIFICATIONS FOR 33-IN. CAST-IRON CAR-WHEELS.

DESIGN.—The design of wheels must be such that they will be in accordance with the measurements shown in the drawing accompanying these specifications, and also such that the wheels made from them shall weigh between 525 and 575 pounds each.

INSPECTION.—Wheels must all be cast in true metallic chills of the same internal diameter and uniform cross section. The treads must be smooth and practically free from "sweat," and must have clear white iron extending to a depth of not less than ¼ in. at the throat, and with a variation of not more than ¾ in. throughout the same wheel. Each wheel must be so nearly cylindrical that when a true metallic ring is placed upon the tread and bears somewhere on the cone, it shall, at no part of the circumference, stand more than $\frac{3}{32}$ in. from the wheel-tread. No wheel will be accepted whose circumference differs more than 1½ in. or less than 1 in. from the circumference of the chill in which it is made.

The body of the wheel must be composed of soft gray iron with uniform fracture and free from defects; each wheel must be capable of withstanding a pressure of 45 tons in mounting an axle.

TEST.—Representative wheels taken at random by this company's inspector will be subjected to a strength test, under a falling weight, in a machine like that shown on drawing accompanying these specifications, with an anvil block weighing 1,700 lbs. set on rubble masonry 2 ft. deep. Manufacturers furnishing wheels to this company will be required to provide one of these machines, and furnish wheels for test, as well as such facilities to the company's inspector as will enable him to test and inspect wheels promptly; they will also be required to give notice to Superintendent Motive Power when wheels are ready for inspection and test. The wheels tested will be placed flange downward and rest upon the three supports on the anvil block, and be struck central upon the hub with a weight of 140 lbs. falling 12 ft.

For each 100 wheels which pass inspection at foundry and are ready for shipment, one representative wheel shall be selected and tested as above described; should this wheel stand five blows without breaking in two or more pieces, the 100 wheels may be shipped; but should this wheel break in pieces with five blows or less, two more wheels representing the same 100 wheels shall be taken and tested, and if any two of the three wheels tested should break in pieces with less than three blows, or if the average number of blows required to break the three wheels is less than four, the 100 wheels will be rejected: otherwise they may be shipped, but the shipment in any case will be made subject to the return of such as are found, upon boring and mounting, not to conform otherwise to these specifications.

MARKS.—When wheels are manufactured under these specifications, each wheel must bear a serial number, with name of maker and date of casting.

Contributions.

The Heating of Railroad Cars.

To the Editor of the Railroad and Engineering Journal:

ASSUMING that steam from the engine will be generally used, the matter most requiring to be tested for the solution of this problem is how to supplement steam from the engine for the time when is cannot be used, before the cars are connected with it, and when it is disabled away from terminal points. Why then are the tests now being made confined to the former use (requiring only a choice between several methods to find the best), while for the latter use, nothing is done, although without providing for it the question cannot be settled?

As further proof of the necessity for extending the tests now being made, as above suggested, I add the following facts:

1. Relating to Steam from Stationary Boilers: The advantage of this method is that it answers the purpose before steam from the engine is available. Its disadvantage is that it answers no other, and in answering that, requires, in case when (as at the New York terminus of the Pennsylvania road) several trains leave at the same time, or nearly so, that the track system be reorganized; and, in all cases, that new and costly investments shall be made at all stations when trains are made up and kept always ready for use.

2. Coal stoves and heaters, the means relied on at present for supplementary heating, are not practical for that use, as they require the fuel to be removed from them in a glowing state and after short use, and therefore are too wasteful, troublesome and dangerous for use at depots. When the engine breaks down, when a stove or heater is kept in a car for that contingency alone, there would be much delay in heating it up in time, and it would be filled with burning coal when the train began to move.

3. Assuming that neither of the methods above described for heating cars before steam from the engine is available for the purpose are practical, it follows that so far as that operation is concerned, the car-heating problem is narrowed down to the enquiry, "Can gas be used for it?" In answer to which, and as proof that I appreciate the conditions required to make the use of gas on cars practical, I here state them:

The furnace used for it must burn the gas without waste, and (as heat alone and not the impact of flame must be used) must be so arranged that any undiluted heat can enter its flues, as otherwise the cost of its operation would be too great. It must not require inconvenient alteration of the car. It must be supplied by gas-pipes under the cars and connected between them, as steam pipes now are, so that when the gas used comes direct from street mains, all the furnaces in a train could be supplied from one connection with said main, turned on when the heating commenced and off when the engine came.

It must not only heat the car, but be capable of heating it quickly when required for emergencies, or in extreme cold weather. And, if possible, the heater should be so constructed that it can be changed from a gas to a coal burner or back again in a few minutes and without other change than loosening a few screws, to provide for the contingency of the engine being disabled away from terminal points, and in cases when trains are made up when there is no gas. That is the case when gas is used only for heating—when it is used for both heat and light, of course the gas in the storage tanks could be used, and the change to coal would not be needed.

Assuming that gas can be used as above stated, and the apparatus for its use so arranged that it can be taken directly from street mains while the cars are being heated up, and then shut off, so that only one heating with gas would be required for a route, however extended it may be, can any other method be safer, cheaper or more convenient? As neither storage tanks, under the cars, or special gas works would be required, except at great cities and by trunk lines, when the use of gas, if used for both heat and light, would be so great, that economy would demand its manufacture by private works.

Again, the use of mineral oils being now forbidden on cars, either gas or electricity must be used for lighting

them, whatever means are used for heating them, so that the use of gas for both purposes is really the simplest method known.

I think that what I have written gives sufficient reason to show the necessity of testing gas as well as steam without further delay.

H. Q. HAWLEY.

THE ENCYCLOPEDIC WORK OF THE NAVY DEPARTMENT.

BY PROFESSOR R. H. THURSTON.

THE Bureau of Navigation of the Navy Department has during a few years past been engaged in a most important and interesting work, that of securing information of value to the officers of the Navy and to the Administration through the many sources open to it, and publishing it for distribution to the service and wherever else it is proper to send it. This work is done through a subbureau called the office of Naval Intelligence, the direction of which is entrusted to an able officer of the Navy and supervised by the Bureau of Navigation. Much of its work is revised by the Secretary of the Navy himself, and all publications are authorized by the Department and printed under its orders at the Government Printing Office in the excellent style for which that office is noted. Out of a long list of these publications a few are selected for notice.

The work of the Bureau of Navigation in this direction began many years ago, and those who have been so fortunate as to obtain the treatises issued during the administration of the late Admiral Jenkins, during and since the civil war, on the magnetism of ships and kindred subjects, have been as long aware of the excellence of the work done. Among the publications made under the direction of the Office of Naval Intelligence, having peculiar interest and which may be briefly noticed, are the report on the War between Chili and Peru in 1879–'81, by Lieutenant T. B. M. Mason, printed in 1885; the report of Lieutenant Commander C. P. Goodrich, 1882, on the Naval and Military Operations of the British Forces in Egypt, published in the same year; and the reports on Recent Naval Progress, by Lieutenant S. Schroeder, Ensign S. D. Greene, Assistant Engineer R. S. Griffin, Lieutenant W. H. Driggs, Lieutenant W. I. Chambers, Lieutenant W. H. Beehler, Ensign W. L. Rodgers and others.

The first mentioned report, that of Lieutenant Mason, is an exceedingly interesting account of the origin and conduct of the war which broke out in 1879 between the two principal South American republics on the west coast. It will be remembered that this war was a consequence of a quarrel between the two countries over the nitrate of soda deposits of the Atacama Desert, the Bolivian Government having broken treaty obligations and imposed a tax upon the nitrate business which interfered seriously with the prosperity of its managers. Peru interfering in the quarrel, and arming herself for a conflict, Chili declared war April 2, 1879. Three days later the blockade of Iquiqui was declared, and within two weeks fighting began in earnest.

Lieutenant Mason gives a very concise but satisfactory account of the resources and condition of the belligerents and of the operations of the war, both on land and at sea.

The most interesting and instructive part of the narrative is probably that in which he describes the naval contests, and especially those in which the now famous iron-clad *Huascar* took part. This ship was a "monitor" iron-clad, or turret-ship, built in 1865, for the Peruvian Government, by Laird Brothers, of Birkenhead, the firm which gained an unsavory fame during our civil war as the builders of Anglo-Confederate war vessels, and as nearly involving their own country in war with the United States by their infringement of international law. The description of the fight, on October 8, 1879, between this ship and the two iron-clads, *Admiral Cochrane* and *Blanco Encalada*, of the Chilian navy, is one of the most interesting, though horrifying, stories of naval warfare ever published, and affords a tremendous indictment of this method of settling international disputes. The result of the action was the capture of the *Huascar* by the Chilians, after the almost complete destruction of ship and crew. For about an hour and a half the Peruvian ship was under the fire of one, and, part of time, two iron-clads of greater power and much better armored than herself, and the effect of their fire was simply terrible, breaking up all of the vessel above water, destroying all her boats, and disabling turret and conning tower. The cabins and turret were crowded with the fragments of human bodies; yet the gallant men who survived fought until the enemy had actually boarded their ship and held their pistols at their heads.

The capture of the *Huascar* practically ended the contest on the sea, and the war was then fought to a close on the land. Chili had, from the first, every advantage, and gained victory after victory until Peru became prostrate before her armies, and she was able to dictate her own terms.

The report of Lieutenant-Commander Goodrich on the British naval operations in Egypt, in the summer of 1882, is a very extended account of that remarkable outcome of the modern methods of warfare, if that can be called warfare which consists in the attack of such a very powerful nation upon such a very weak one. The report also illustrates well the extent to which the amenities of modern life and civilization have been imported even into the greatest surviving relic of barbarism, the fighting of nation with nation. The information contained in this report could only have been gathered with the assistance of the British officers engaged in these operations; and Mr. Goodrich makes graceful acknowledgement of such aid.

The report is divided into three parts: An account of the causes of the outbreak of hostilities, and descriptions of the attacking and defending forces and of their naval and military material, including ships, fortifications and guns; an account of the various naval and military operations of the war; and the study of the non-combatant divisions of the service. A very interesting and exact account is given of the defenses of Alexandria, of the armored and other vessels employed by the British Government in the attack, and of the effects of the fire upon the ships and fortifications. The operations of the fleet after the bombardment of the Alexandrian forts and other operations preceding the change of base at Ramleh, the composition of the expeditionary force, and the steps taken resulting in the seizure of the Suez Canal, and the

remainder of the short but decisive campaign are fully detailed.

Perhaps as interesting a portion of the report as any, to civilian and scientific readers, is the account of the methods of operation of the railroads, the telegraph system, the post-office, the medical department and the systems of transport. A comparison of the Indian troops with the British in their methods of operation, their habits of life, and their value as soldiers and in the army organization is not the least interesting portion of this very interesting work.

It has been asserted by many who should have been trustworthy and accurate witnesses that the war upon the *de facto* Government of Egypt, initiated by the bombardment of Alexandria, July, 1882, was entirely without real cause or justification, and this was very strongly held and promulgated in many addresses, given at the time, in various parts of this country by American ex-officers of the Egyptian Government. Acording to the British accounts, and the statement is supported by Commander Goodrich, the fact is that a set of native and foreign officers had gradually "wrested the power from the hands of the Khedive, their legitimate ruler, and had wielded it in such a manner as to paralyse trade, destroy confidence, and cause the foreign population to desert the country by thousands." The concentration of the British naval forces in the harbor of Alexandria only stimulated the feeling against foreigners already threatening the destruction of all such citizens; and the strengthening of the fortifications, which was caried on under the very guns of the British fleet, in spite of protests, indicated an intention of resorting to violence should the relations between the native and the British parties become more strained. It was thought best by the British commander to send to the Government of Egypt an *ultimatum*, threatening to attack the forts in the harbor should the mounting of guns not be at once discontinued and those in process of installation removed. This demand was not acceded to, and the result was the initiation of a campaign, the general outcome of which is well known to every intelligent reader of the daily press.

We cannot attempt the formal review of so extensive a document, and must be content with the briefest possible notice, and a few extracts illustrating the extent and value of the mass of information collated by Commander Goodrich. The report is well illustrated by engravings exhibiting the character and general construction of the British iron-clads engaged at Alexandria, the extent and disposition of the forts, and the nature of the apparatus and material employed. Good photo-gravures of the exterior and interior of the forts after the bombardment exhibit well the effect of the shot thrown from the heavy guns of the vessels of war, and maps and plans are introduced wherever they can be made useful. Thus the bombardment of Alexandria, an event having very little significance in itself, perhaps, and having none of that peculiar interest which attaches to bloody engagements and well-fought fields, is made a means of instruction in the arts of naval and military engineering, such as seldom if ever had been previously obtainable. Some of the conclusions derived from the study of this bit of war are the following: The height of a fort above the sea level is a matter of the greatest importance, a slight rise giving, often, great advantages. This was well shown during our own civil war by the misfortunes of the *Galena* and her sister ships on the occasion of their attack upon the forts on the high bluffs on the James River. The vessels were seriously damaged, while the forts were uninjured.

At Alexandria, a difference of 14 ft. in the altitudes of the Lighthouse Fort and Fort Pharos gave the latter an enormous advantage, and it suffered comparatively little, while the former was badly cut up and its guns very generally dismounted. It was found, also, that no projectile mounted in the British fleet was capable of sending a shot through 30 ft. of earthwork, though some of these guns were of 81 tons weight, and it is even doubted whether the 100-ton gun with its 40,000 foot-tons of stored energy could drive a shot through that thickness of earth. Lines of fortifications should be, wherever possible, unbroken, and the guns should be of the same color as the masonry in order that the gunners attacking them should not be furnished with a target at which to aim with exactness. Low-powered guns of high trajectory are considered best for the attack of earthworks. High-powered guns, with their low trajectory, drive their shot in at the limit of maximum resistance. Ships should, on such occasions, have composite batteries. Perhaps the most important of all lessons taught by this incident of war are that vessels are not and cannot be expected to be able to fight on even terms with forts or shore batteries, and that, on the other hand, the latter are utterly powerless to stop the progress of any well-handled and satisfactorily-armored fleet of the present day. The fleet may pass on without so much as noticing the fort and with almost perfect impunity. The art of defense has so far outstripped that of offense that each system, as constructed to-day, is practically unconquerable by the other. The same fact was well illustrated in our own last contest by the permanence of the defenses of Charleston and by the passage of the forts at New Orleans by Farragut's fleet. The fact that the latter was a wooden fleet emphasizes the advantage possessed by the warship in its mobility.

Among the miscellaneous conclusions which attract attention in the midst of the encyclopedic mass of information here given us, is that which Lieutenant Greeley also reached after his experiences in the Arctic regions: that "grog" was not only useless, but that the troops were better without it. Accordingly the ration issued ordinarily was changed, increasing the allowance of tea, adding lime-juice, substituting potatoes and rice for fresh vegetables when they were obtainable, and abolishing the daily "tots" of rum. It is interesting to read that "great dissatisfaction was felt on the part of the British officers with the lack of a means of summary punishment to take the place of flogging" now abolished, a feeling also expressed on somewhat different grounds by many citizens of Chicago since the trial of the anarchist murderers in that city. It is stated, in referring to the use of the filthy waters of the "Sweetwater" Canal, that they did not, so far as could be observed, produce disease. Diarrhœas were caused by the heat and exposure of the campaign, even where the men were given distilled waters. "Heat apoplexy was probably the only true climatic disease." Antiseptic surgery was employed from the first, and with good results, carbolic acid being the antiseptic commonly employed. Mercuric chloride, the favorite antiseptic among our own surgeons, does not seem to have been generally used. Hospital accommodations and the hospital service generally were not always of the best, although

in some cases the refinement of charity went so far as to provide *iced champagne* among the medical stores actually issued.

One of the last of the many recommendations of this instructive report is one which will appeal strongly to every executive officer in our colleges as well as in other administrative positions:

"The practice of mentioning juniors in despatches . . . is one of the most marked features of all the official reports . . . The sense of duty well done may be all that an officer has a right to expect; but, until human nature changes entirely, even the most conscientious person will not fail to find a stimulus to still greater exertions in the field, or more prolonged and earnest labors in the cabinet, in the thought that his efforts, if successful, will become part of the annals of the service to which he devoted his life without reserve."

The last of this series of publications which we have occasion to notice is that on Recent Naval Progress, published by the Navy Department in June, 1887. It makes a volume of about 350 pages and is full of important and interesting information relating, mainly, to purely naval matters. Perhaps the most important paper of the collection is that with which the volume opens, a contribution by Lieutenant Schroeder on the Development of Modern Torpedoes, which is supplemented by an appendix, describing experiments at various British and other European ports. The introduction of the torpedo into warfare is a recent event, notwithstanding the fact that the invention originated at a comparatively early date. Bushnell's floating torpedoes of a century and more ago, and their use in the War of the Revolution, are well-known historical events; while the rhymes describing the "Battle of the Kegs" have taken a permanent place in our literature.

It is also a fact familiar to every student of history that Robert Fulton, a little later, made some effort to work that promising field of invention, and succeeded in producing effective torpedoes, and in operating them by means of a submerged vessel impelled by a screw which was probably the best submarine boat ever constructed up to the date of our own civil war. It is not surprising that this should have always been a most attractive department of work for ingenious mechanics.

No one can fail to recognize the fact that it is to such developments as we are now witnessing that we are to look for that final outcome of military and naval progress which is yet to make war between civilized nations impossible in consequence of the very efficiency of their implements and machinery of destruction. When the torpedo system has become to such an extent perfected that no fleet can with safety approach the shores of an enemy, and that the most powerful iron-clads and rams will certainly be destroyed whenever they come into the presence of a fleet of torpedo-boats, the whole cost of that fleet being less than that of a single first-rate armored vessel, naval wars, at least, will cease, and disputes among nations will be brought much nearer to adjustment by discussion and arbitrament, and will be settled, if worst comes to worst, by the proclamation of non-intercourse, the penalties of which in the interruption of internal business and inter-state trade will be amply sufficient to bring about a settlement. The perfection of the torpedo, in its several forms of fixed, floating, movable and automatic apparatus, will be thus seen to be a matter which must be of vital importance to every nation, and especially to one which, like the United States, is disposed to rely upon the more decent and civilized methods of preservation of the peace. Not only is the torpedo the only reliance of our country in case of a war with a foreign nation, but it is that form of instrument of warfare which is most likely to put an early end to all naval contests. The torpedo also has a place in army operations; but there it is of vastly less importance. The perfection of ordnance, small and large, insuring the destruction of any force that may be exposed to fire is what we must rely upon to insure a similar issue on land.

Lieutenant Schroeder's report report gives a very full account of all the approved forms of torpedo, from the towing apparatus and torpedo of Harvey to the automatic torpedo of Whitehead and that of Lay. The projectile torpedoes, among which is the Ericsson, as fitted to the *Destroyer*, are not the least interesting of the numerous forms of this weapon. It is a form which Fulton and many later inventors had great faith in, and it is expected that it will in time prove useful, Rocket torpedoes for naval purposes are not considered promising. The fish torpedo, as that of Whitehead, in which the power is stored in the instrument itself, and which is, in the case of Lay's invention, capable of being guided from the vessel or the shore, as an instrument of aggression is of the highest rank. It is a singular fact that the device of Whitehead is not held by patents but by the retention or sale of the secrets of the inventor. These torpedoes are now made up to 20 ft. in length, attaining speeds of 27 miles an hour, using air compressed to a pressure of 1,500 lbs. per square inch and carrying a detonating charge of 100 lbs. of gun-cotton. Howell's torpedo is an ingenious and effective application of the principle of transformation of energy. Commander Howell uses a fly-wheel which is driven up to an enormously high speed—10,000 revolutions a minute—and thus stores power which is later applied in the propulsion of the screw of the torpedo. It is wonderfully simple in design and construction and is reported to be very promising in its performance.

The Lay torpedo differs from the preceeding forms in the very extraordinary fact that it is controllable from the ship or from the shore while in motion. Many modifications of this general plan by various inventors have been tried, some of them with promise of success when experience shall have given the clue to the methods of perfecting them in details. Liqueified carbonic acid is the working fluid for its engines, and both engines and rudder are controlled by an electric current through cables trailing behind the torpedo as it shoots ahead at the rate of, sometimes, over 20 miles an hour carrying a charge of 200 lbs. of dynamite against the enemy with a certainty of his destruction which is not approached by any other instrument of the class. As improved by Patrick this is the most formidable of all recent "peace-compellers."

The other papers in this valuable collection are, in many cases, as important and as exhaustive as that just reviewed and the volume, as a whole, has very great value, not only to the naval officer, but to the engineer in civil life, and to many others interested in applied science.

THE PRINCIPLES OF RAILROAD LOCATION.

By Professor C. D. Jameson.

CHAPTER II.

RECONNOISSANCE.

As we have before stated, a man to excel in location must have a natural talent for it. It must be born in him—something never to be acquired. So now let us say that it is in reconnoissance that this born locator has the best chance to exhibit his talent. Anyone with proper instruction can do the surveying needed on location when he is told what to do; he can run any line when the line is pointed out to him; but it needs the man with the natural talent, improved by study and practice, to point out the best line for a railroad in any kind of country.

In every way the reconnoissance is the most important part of the conduct of a railroad location, and under no circumstances should this work be delegated to an assistant.

This reconnoissance of a country which precedes a railroad survey is an examination, made with extreme care, of that section of the country through which the railroad may pass, or at least all that part of the country that lies between the terminal points which have been decided upon previously. The object of this reconnoissance is to find, by means of the eye, principally, where the best line for the railroad lies between the terminal points. The engineer must have a perfect understanding as to the kind of railroad he wishes to locate, in regard to the amount of probable traffic, the class of traffic, and all the other points mentioned in Chapter I.

By the best line, the engineer must remember that the one with the least work in construction is not necessarily meant; neither must all his endeavors be toward the shortest line. But the best line, as has been said before, is where the minimum of both construction and operation expenses meet.

There is one idea which the young engineer should have firmly impressed on his mind, and that is, that, no matter in what country he is, there is somewhere a good line for a railroad between any two points. By a good line we mean one that is eminently better than any other. Also, let him always have the idea that this best line is not the one he thinks it is at first, but one that can only be found after careful examination. In this examination the object must be to get a good general idea of the topography of the belt of country to be examined; to get the position, direction and size of all the water courses; the position and relative height of all the controlling points, such as the different passes through the hills or mountains, water-sheds, etc.; the position of small intermediate villages, that is, such villages as are not of enough importance in themselves to make it advisable to spend much money in building the railroad to them, if a better line, both in construction and operation, can be found by leaving them to one side. In fact, the object of this examination is to get a perfect idea of the country without taking up too much time.

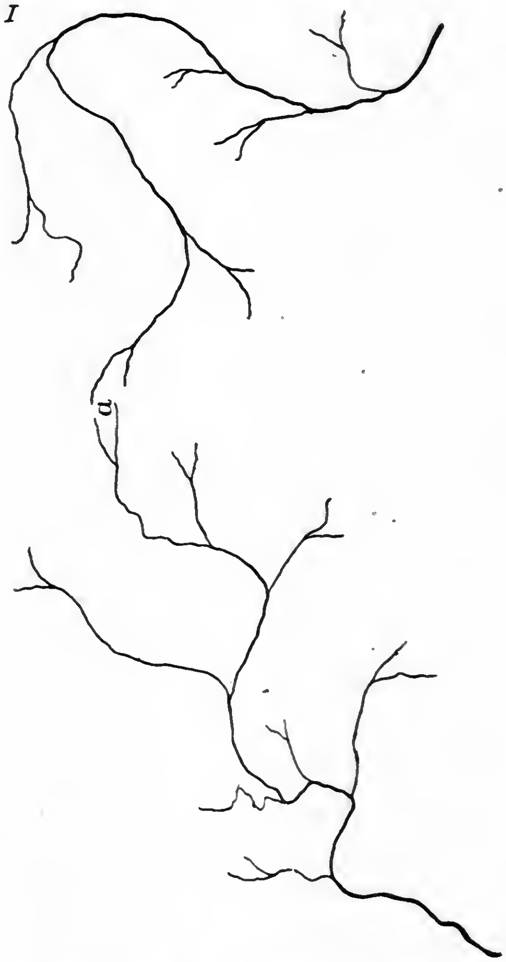
The manner of accomplishing this object is as follows:

The engineer in charge of reconnoissance should get the very best maps of the country that can be procured. In most cases, these will be anything but satisfactory; still, a very good idea can be obtained of the more prominent topographical features. These maps should be studied with great care, until the required section of country is memorized, and a complete plan made of the manner in which the reconnoissance in the field is to be conducted. Notes in sufficient quantity should be taken, so as not to burden the memory of the engineer in any way more than is necessary.

When he has notes of all the principal points that he wishes to visit and examine, let him find out all the best ways of getting there, and make all his arrangements so as to lose as little time and cover as much ground in the field as possible.

In studying the maps before going into the field, and

PLATE I



afterwards in examining the ground, let the engineer remember the following points:

The position and direction of the water-courses will give him always the lowest land, and, if the proposed railroad crosses a divide between two water-sheds, the water-courses will mark the position of this divide and also the different passes through it.

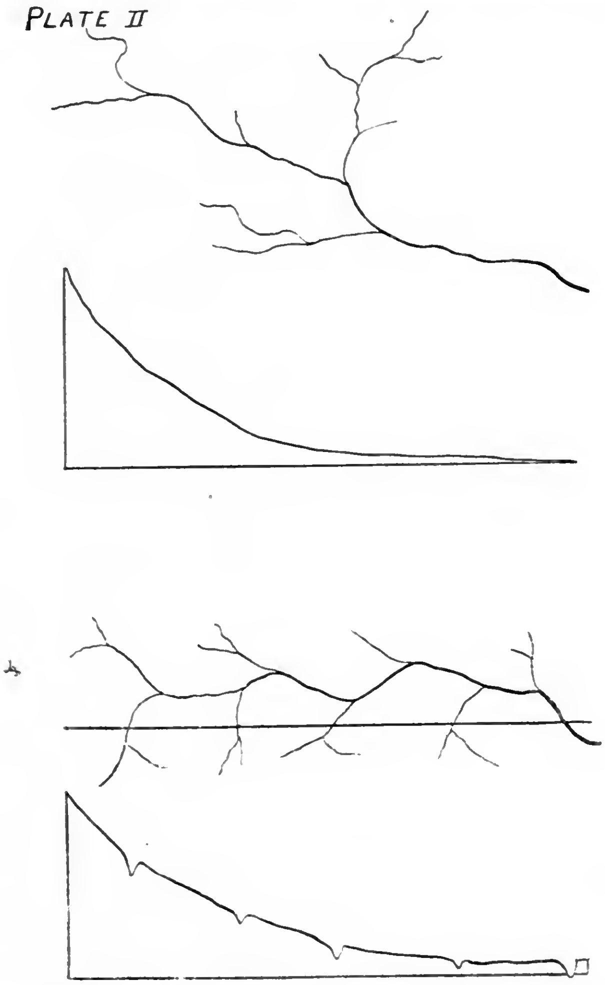
The rate of fall of the water-courses gives the grade of any railroad built along their banks, and this grade will always be found to be steeper near the source of the river, and to gradually grow less as the distance from the source grows greater. Where the course of a stream is comparatively straight, the rate of fall is usually much greater than where it winds and turns a great deal. Any line which follows the course of a river must cross all its tributaries, and thus often necessitates deep fills and many bridges.

Any line which runs along a steep hill-side is in danger

of slides and wash-outs, but in construction side-hill work, that is, where part of the work is in cut and part in fill, is much cheaper than a through cut or fill, as the material that must be excavated to make the cutting is used to form the fill, without any of the expense of cartage. When the hill-side is of rock, there is very little danger of slides, and there is a very great difference in the cost of construction, as it is a very great expense to remove the rock from a through cut, even after it has been broken up by blasting; while, in the case of a side-hill, by a judicious use of the drill and explosive material, the bulk of the material is at once thrown out of the way by the explosion, and the remainder can be rolled down the hill at slight expense. (See Plate III.)

When the young engineer first goes into the field on

PLATE II



location, he must not feel any doubt as to the success of his work if the country is very much broken and mountainous, for the reason that an exceedingly rough country is often much easier to locate through than a more level one. The reason of this is that in a rough, broken country there is less left to the judgment of the engineer. The topographical features are very decided. Nature has often located the line and almost staked it out, and as the engineer has simply to follow the line so plainly held up to view, there is very little chance of his going wrong.

On the other hand, in a more regular, even country Nature has not shown in such a definite manner which is the best line, and the engineer has more work to do in order to find among the many possible lines which is the best; and the greater call there is upon human judgment the greater chance there is for error.

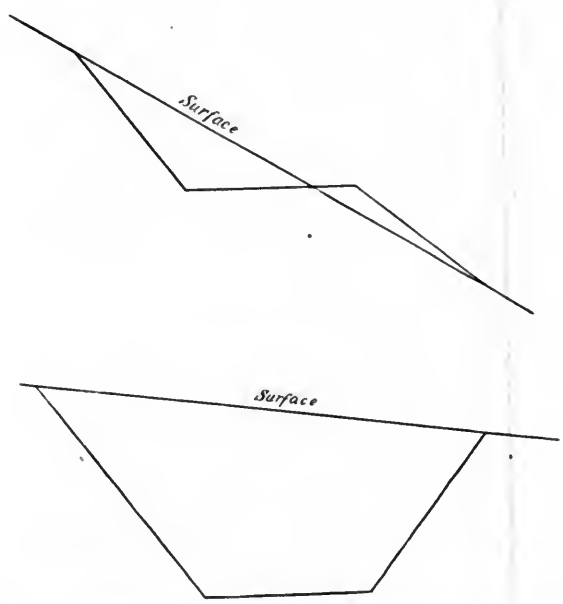
An illustration of the different profiles that can be obtained by different lines running between the same terminal lines is given in Plate IV.

All the different lines shown run from *A* to *B*, and the line which gives the smoothest profile is the line *c*, which keeps nearest the sources of the river; it is also the longest line.

In work in the field, the young engineer must take much care that he does not judge of the difficulties of building the railroad to a certain extent by the difficulties he has in getting over the ground. Often, on ground where it is almost impossible for the engineer to pass at the time of the reconnoissance the lightest work in construction will be found. In the same way, the reconnoitering engineer must not confine himself to highways and the open country. This is always a temptation, and the location of parts of many railroads has been ruined by it.

In making a reconnoissance, it should be made on horseback or on foot, and the engineer should have with him, as guides, one or more of the inhabitants of the coun-

PLATE III



try who know all the short cuts, passes, rivers, streams etc.

Now, in examining the ground, the work should be done slowly and carefully, the engineer taking copious notes and sketches. When he has finished, he must be so familiar with the whole country that he can at any time call up a mental picture of it, with its mountains, rivers and other topographical features, so that he can at once see mentally the obstacles that would be encountered by any line running between the terminal points.

One point that should be studied by all engineers is, to be able to look at a piece of country and make a reasonably exact guess as to the cost per mile of constructing a railroad across it. This can only be acquired by long practice. The only persons we have who are in any way expert at such estimating, are old railroad contractors, who, from their long experience, can guess with most wonderful exactness at the number of cubic yards to the mile that any country will run.

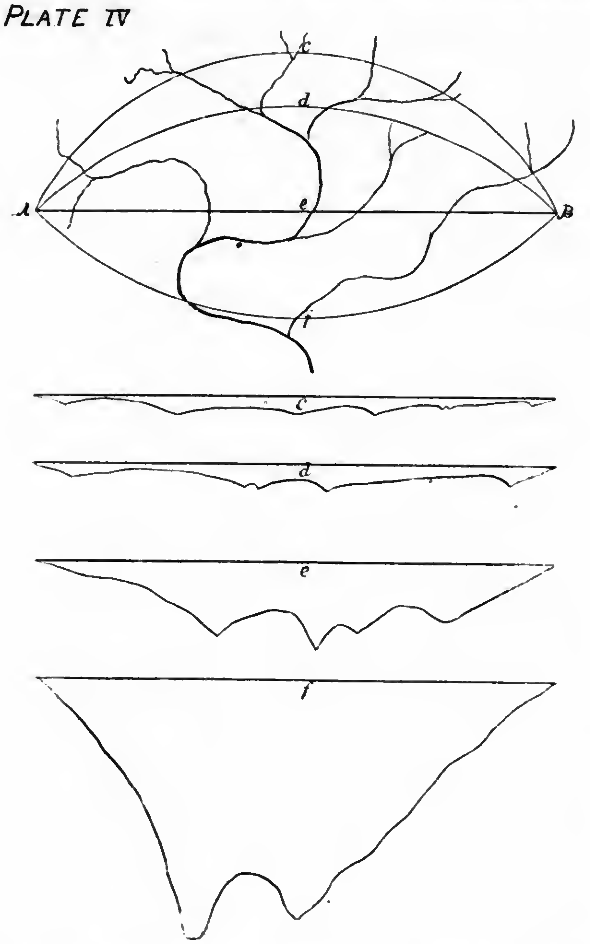
Another thing to be guarded against in the field is optical delusion. In most situations it is almost impos-

sible to judge, with any degree of exactness, of altitudes, or even whether the ground is inclined up or down hill, by the eye alone. When one looks at a hill or mountain, it always has the appearance of being much steeper than it really is; rivers and streams appear to fall much faster than they really do.

Let the engineer by practice find out what his "personal equation" is and then regulate his estimates by it.

With a good reconnoitering engineer, one of the class we spoke of in the beginning, who has natural talent and plenty of practice, and who has given him what time he needs on the reconnoissance, the work of surveying will be very much decreased. In most cases it will be necessary to run only one through line; of course, many of the details of this line will have to be run and re-run, but with proper attention to the reconnoissance, the general line and the grades

PLATE IV



that can be used can be decided upon, once for all. Of course, it takes a thoroughly competent engineer to do this, and the majority of our engineers put upon location are not competent on this point. This is not so much the fault of the engineers as it is of the railroad companies. Until within the last few years they would not pay properly for a locating engineer, and naturally could not get first-rate men for third-rate pay. The engineer hurried through his work on location as rapidly as possible, and with as little work as possible, and jumped at the first chance on construction that offered as a situation where he would get fair pay for fair work.

One great trouble our engineers have is that, as soon as a company has decided to build a railroad, its managers are so anxious to commence the work of actual construction that they allow very little time for reconnoissance, and consequently the work is only half done. The company has to pay for this neglect when the road comes to be operated.

In speaking above as to the class of engineers who go on location, the author wishes to say that he has met with many honorable exceptions, men who had done everything to improve a great natural talent for locating and reconnoitering, and who had arrived very near perfection.

In this work of reconnoissance, the three elements which the engineer wishes to find quickly and with approximate accuracy are distance, direction and altitude. The distance passed over can be taken with sufficient accuracy by means of the time occupied in passing from point to point. Very little practice will show the engineer at what rate he moves either on foot or horseback and if the journey can be made in a wagon, then an odometer fastened to the wheel will give the distance.

By direction we mean the position of one prominent point in relation to others, the courses of the rivers, streams, etc. By altitude we mean the height of all the desirable points, such as passes, water-sheds, etc., above some known height, usually the sea-level, the rate of fall of the rivers, streams, etc. The instruments by means of which these required data are obtained must be of such size and form as not in any way to inconvenience a man walking or on horseback, and their methods of use must be such that the required results may be obtained with minimum loss of time. For altitudes we use the Aneroid Barometer and the Hand-Level, and for direction the Pocket-Compass. These instruments, with the methods of using them, will be described and illustrated in the following chapters.

CHAPTER III.

THE ANEROID BAROMETER.

The use and construction of the barometer is based upon the following facts: The earth is surrounded by what we call the atmosphere or air. This atmosphere is known to be about 45 miles thick, that is, it extends 45 miles above the sea-level. A column of this air 1 in. square and about 45 miles long weighs 14¾ lbs. We do not feel this weight or pressure under ordinary circumstances, because we are entirely surrounded by the atmosphere, and the pressure is exactly the same in all directions, and consequently balances. But if you place your hand over the end of a pipe, and all the air is exhausted from the pipe, then you have the sensation of your hand being sucked into the pipe. This is merely the pressure or weight of the atmosphere acting on the other side of your hand, and you are sensible of this weight, because the counter-weight or pressure on the other side has been removed.

The air is much more dense at the sea-level than at some distance above it, owing to the greater weight from above pressing it down. Therefore, the higher you get above the sea-level, the less is the weight of the atmosphere, owing to the fact that the column itself is shorter and that the atmosphere is less dense.

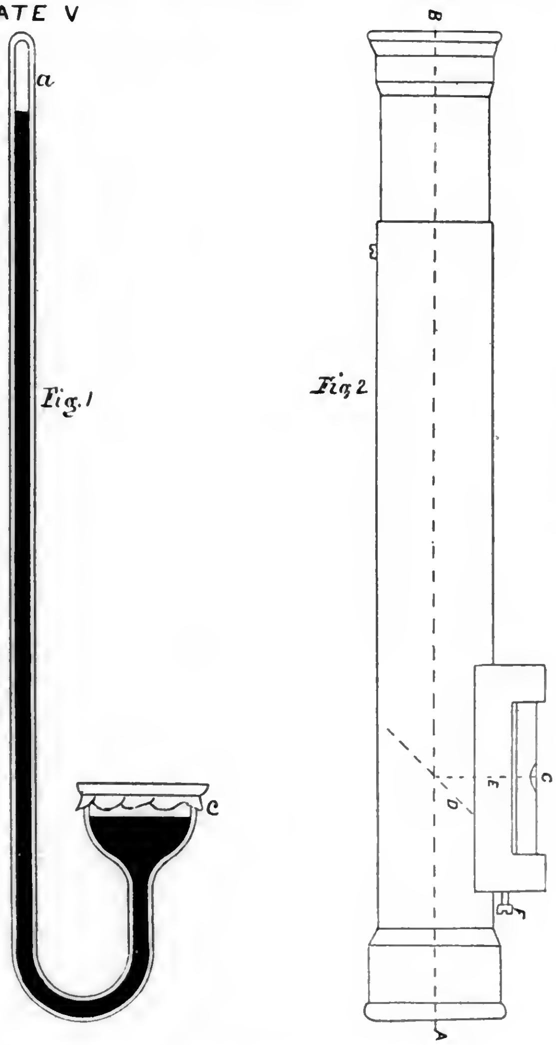
It is upon this fact, that as you rise above the sea-level the weight or pressure of the atmosphere becomes less, that the use and construction of the barometer for obtaining altitudes is based.

The cistern, or mercurial barometer, Plate V, fig. 1, consists of a graduated glass tube, *a b*, with a bulb or cistern, *c*, at the bottom. The air is all exhausted from the tube,

and it and the cistern are partly filled with mercury. The top of the cistern c is then covered with some air-proof elastic substance, such as rubber.

The air having been exhausted from the tube, the weight of the air at c forces the mercury up in the tube, until the weight of this column of mercury just equals, or balances, the weight or pressure of the atmosphere.

PLATE V



At the sea-level, when the atmosphere weighs 14¾ lbs., the column of mercury will stand just 30 in. high in the tube. As we rise above the sea-level the pressure of the air grows less, and the column of mercury falls. In round numbers the mercury falls 1 in. for each 1,000 ft. we rise; so that, knowing this, we can tell approximately how high above the sea we are by the height of the mercury in the tube.

The mercurial barometer, with its glass tube over 30 in. long, is a most inconvenient and delicate thing to carry. The barometer used, therefore, for taking heights in the field, is what is called the aneroid barometer. The principle upon which it works is exactly the same as the mercurial barometer, namely, the decrease in atmospheric pressure as we ascend.

Plate VI represents a section of an aneroid barometer, showing the interior mechanism. Plate VII is a perspective view of the same. *A* is a small metal box, the top of which *B B* is corrugated, as shown in the figure, to give it greater elasticity. This box *A* is air-tight, and all the air is exhausted from the inside. Then, of course, the weight of the atmosphere presses in the top *B B* and, as this atmospheric pressure increases or decreases, so the top of the box is raised and lowered. This box *A* is firmly fixed to the bottom of the brass case *P P P P*, which contains all the mechanism.

This up-and-down motion of the top of the box or corrugated plate *B B* is communicated to the needle *M M* in the following manner: On the top *B B* is the post *C*, fastened to the top. One end *T* of the main lever *D* rests upon the fulcrum *O*, and is acted upon from above by the post *C*, which rises and falls with the top of the box *B B*. The end *S* of this main lever *D* is connected by a joint with *E*, which, in turn, is connected with the bent lever *F G*. The upper end *V* of *F G* is connected by a small chain, *J*, to the drum *K*, which is upon the post *W*, which has the needle *M M* upon its upper end.

From this, it can be seen that any motion of *C*, either up or down, is at once communicated to *D*, and from thence through the levers to the drum *K* which, turning one way or the other, moves the needle *M M*. The chain *J* is always kept wound taut around the drum *K* by means of the little spring *L*. The spring *N* is to raise the lever *D* when *C* is raised, and the weight *H* is simply, in some degree, to counterbalance the spring and keep all the levers working on bearings. The plate or circle *X X*, Plate VIII, above which the needle moves, is divided into equal parts which correspond to the inches on the mercurial barometer. The length of these parts, of course, depends upon the diameter of the circle. In a 5-in. barometer the needle is 3 in. long, and the diameter of the circle is the same. In this case, the length which corresponds to 1 in. of the mercurial barometer is about 1½ in. That is, the point of the needle will swing over 1½ in. of arc.

PLATE VI

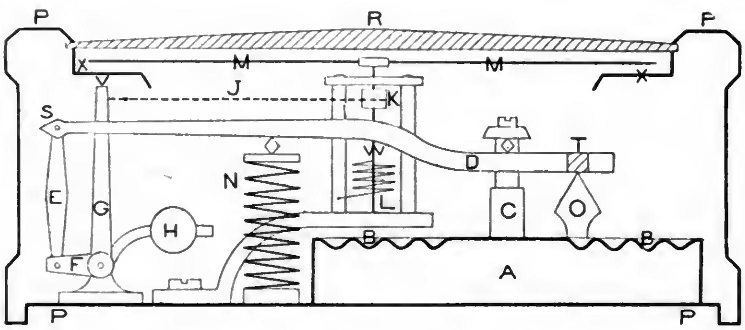
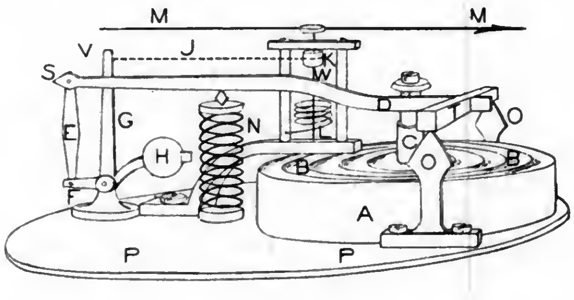


PLATE VII



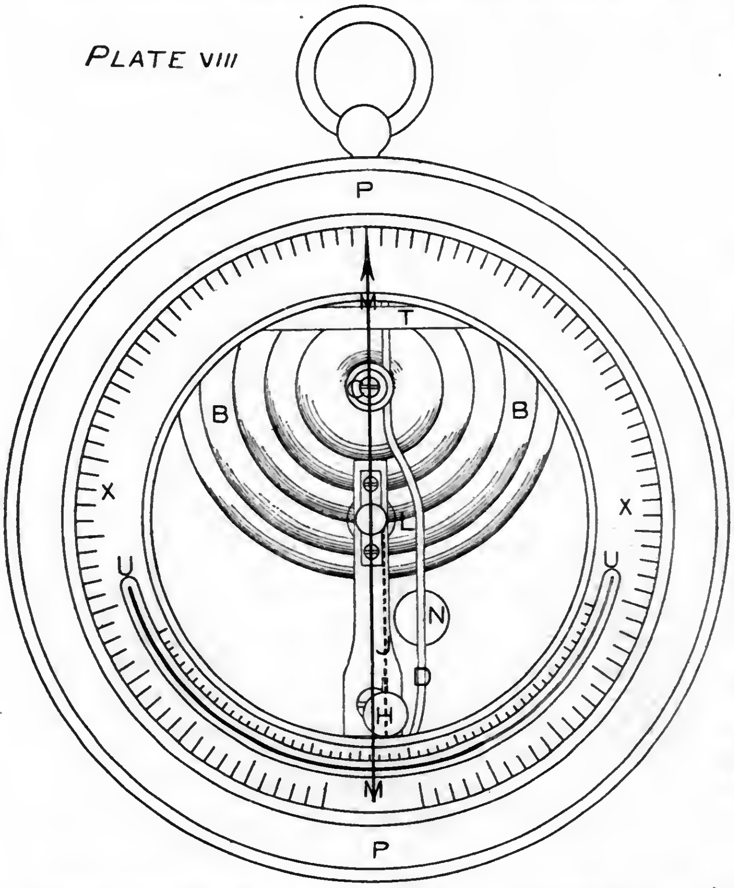
for the same change of atmospheric pressure that would move the mercury up or down 1 in. in the mercurial barometer; and this corresponds to about 1,000 ft. change in elevation of the instrument.

Thus this 1½ in. on the divided circle, which is called an inch, corresponds in round numbers to a difference of elevation of 1,000 ft.

This inch is divided into 10 equal parts, each representing 100 ft., and these again into 10 parts, each equal to 10 ft. These smaller divisions can easily be again divided in half by the eye, so that elevations can be read to less than 5 ft.

The most exact method of using the barometer in determining heights, is to work from some point of known elevation, either back to the same point or to some other point of known elevation, as these given points will act

PLATE VIII



as a check upon the results given by the readings of the barometer.

Before commencing work the aneroid barometer should always be compared with some standard mercurial or aneroid barometer, and any difference in the readings noted; and after the readings at the various points have been taken, the correction should be applied. This is a much better method than attempting to correct the error in the instrument itself by means of the adjusting screw, which is attached to most instruments. The aneroid being a delicate piece of mechanism, it is better to use the correction for a known error, than to take the chances of getting in an unknown error by changing the adjustment.

Although most of the aneroids claim to be compensated for any changes of temperature, still in all work the temperature should be taken with each reading and the proper correction made in working out the heights.

While in use, the aneroid should be held in a horizontal position and allowed to remain in that position a sufficient length of time to permit it to feel the full effects of the changes in the atmospheric pressure. Just before the reading is to be taken, the aneroid should be gently tapped with the finger in order to do away with any sticking of the needle or any part of the mechanism. On any important point, as many readings as possible should be taken, and those results which were taken under the most similar circumstances, should be be averaged.

In using the aneroid on reconnoissance, the object is not so much to get the actual height of the various points above sea-levels, as to find their relative heights; that is, how much higher or lower one point is than another, and this can be done very correctly by the following rule, much care being used when taking the readings:

RULE.

As the sum of the two readings is to their difference, so is 55,000 to the difference in elevation between the two points.

Example:

First reading, 28 in.
Second reading, 27 in.
$27 + 28 = 55$
$28 - 27 = 1$
$55 : 1 :: 55{,}000 : 1{,}000$

the difference in elevation between the two points.

Much care must be taken in the use of the aneroid, as without this care most serious errors will be made and the value of the work lost.

With care and practice, however, results may be obtained of sufficient accuracy to answer every purpose of a reconnoissance. The best aneroids cost from $35 to $50. The mechanism, by means of which the rise and fall of the corrugated top *B B* is made visible to the eye and is measured, differs to some extent in the instruments of the different makers, but the principle is the same in all. Every first-class aneroid has a thermometer, *U U*, Plate VIII, attached to it with which to take the temperature.

Plate VIII is an outside view of an aneroid barometer, showing the face of the instrument.

There are many small, cheap aneroids made and sold to tourists, but they are generally too unreliable for any engineering work.

CHAPTER IV.

THE HAND-LEVEL AND POCKET COMPASS.

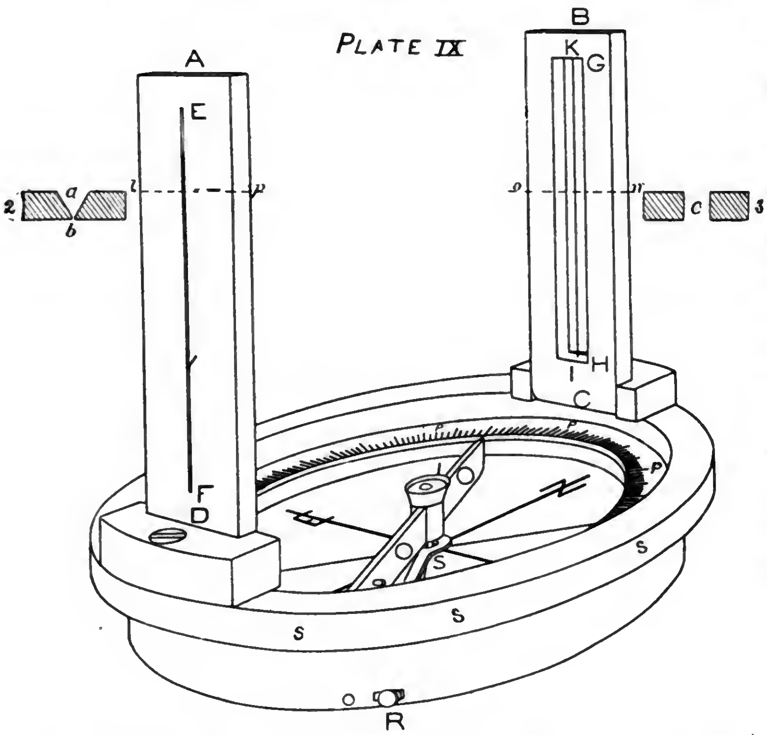
The Locke Hand-Level is shown in Plate V, fig. 2. By simply holding this instrument in the hand and looking through it one can tell approximately all the objects that are on a level with his eyes. In this plate, *A* is the eye end of the level and *B* the open end. *C* is a small bubble enclosed in a brass box which has an opening in the top and one in the bottom. *E* is a vertical wire which runs down from the center of the bubble tube, and is set in a small plate so that it can be moved back and forth by means of the screw. *D* is a semicircular mirror, which occupies one-half the tube and is set at angle of 45°.

The only adjustment of the instrument possible is that of the wire *E*. To adjust this, place the instrument in a perfectly horizontal position, and then if, in looking through it, the wire does not cut the bubble in the center, move it back and forth by the screw *F* until it reaches the proper position.

The Pocket Compass, of which we give a perspective view and plan (Plates IX and X), is used to obtain approximately the direction of one prominent point from

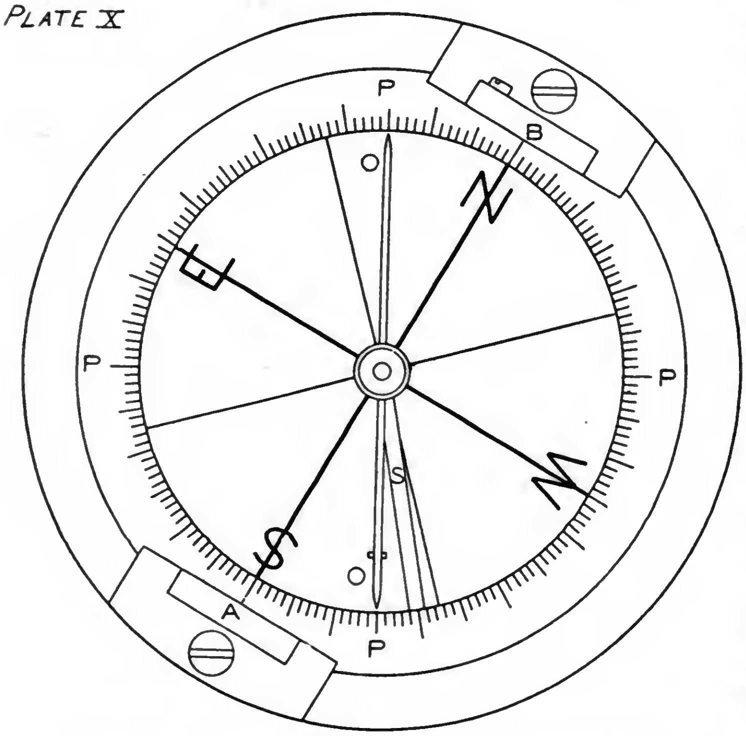
another, the general direction of the water courses, etc. The principle upon which its use is based is simply that of any magnetic compass, that the needle O O will always point north and south when the instrument is held in a position nearly enough level for it to swing freely. We

PLATE IX



will here only describe the simple Pocket Compass with folding sights, because, while there are many other instruments of modern invention which have, to some extent, superseded the use of this upon reconnoissance, their

PLATE X



mechanism and manner of use are more complicated, the principle being still exactly the same.

The ordinary pocket compass, which is shown in perspective in Plate IX, Plate X being a face-view, consists of a brass case, *s s s s*, anywhere from 2 to 5 in. in diameter. On the inside of the case, which is covered with glass, there is a plate, *P P P P*, which is divided into degrees or half-degrees, as represented. Then the four cardinal points *N*, *S*, *E* and *W* are marked on the plate. The magnetic needle *O O* swings freely on a pivot in the center and always points north and south. On the outside of the case and directly in line with the north and south line marked *N* and *S*, Plate X, are two sights *A* and *B*. These sights are pieces of metal a little shorter than the diameter of the case and work on the hinges *C* and *D*, so that they can be shut down over the glass top of the case when the compass is in the box. The sight *A D* has an extremely narrow slit, *E F*, cut in it exactly on the line *N S*. The shape of this slit is shown in section separately. Let *a b* represent a horizontal section through the sight *A D* on the line *l p*, then the point *a* will be the slit as it is on the outside of the sight or the side shown in the cut, and *b* the side of the slit on the inside. The other sight *B C* has a square slit, cut through it as shown, and in the center of this slit and exactly in line with *N S* is tautly stretched a fine wire, *K I*.

The button *R* on the outside of the case connects with the arm *S*, and by moving *R* to the right or left, the needle *O O* is either raised from or lowered on to the pivot at the center.

(TO BE CONTINUED.)

HOW ELECTRICITY IS MADE.

BY LIEUTENANT BRADLEY A. FISKE, U. S. N.

(Concluded from page 505.)

A dynamo was constructed on this plan, the single coil or loop being, however, replaced by a continuous coil of many convolutions wound like a shuttle in a longitudinal groove cut around an iron cylinder. This was the original *Siemens* machine, and an excellent machine it was for its day. It may be here remarked that the revolving coil with its cylinder or core was and still is called the "armature," and that the embracing magnet is called the "field magnet," and sometimes the "field," though the word field strictly applies only to the space between the poles.

But though the current sent to the outside wire was always in the same direction, it is plain that it could not be strictly continuous, because it fell to zero twice during each revolution at the times when the current in the armature changed in direction; and it was by reason of overcoming this defect that the invention of the Gramme machine (or "dynamo," as it is usually called) in 1870 caused such an enormous advance all over the world in the generating of electricity upon a large scale. This machine is shown in fig. 11.

Gramme replaced the single coil of wire, with its ends connected to two brass segments on its axle, by a number of separate coils wound on the circumference of a ring, as shown in fig. 11 *a*, the ring being revolved also between the poles of a magnet N and S, the ends of the coils being connected to each other in such a way as to form a continuous circuit all around the ring and also connected to the various brass strips shown, which were secured separately to the axle. As in the old Siemens machine, two brass brushes to which the ends of the outside wire were attached pressed on these strips in succession, as

the ring or armature revolved. A little consideration will show that each one of the coils in a Gramme machine, in rotating, acts exactly like the single coil already described; and, as the coils are connected together, all of the coils which are on the right side at any instant generate currents

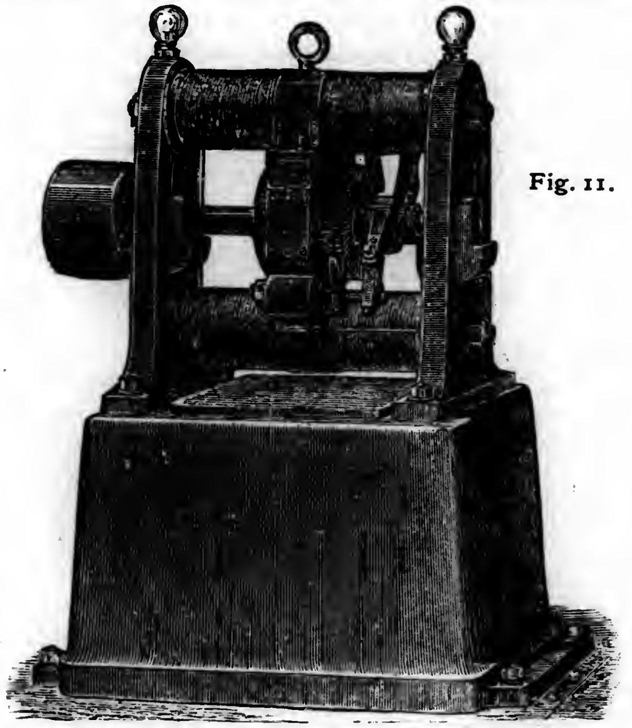


Fig. 11.

in one direction, while all those on the other side are generating currents in the opposite direction, because the right-hand coils are performing the first half of a revolution, and the left-hand coils are performing the latter half. Now, if the currents were in the same direction in both sides there would be one continuous current around the ring, flowing down on one side and up on the other, but since the currents are in opposite directions, they must flow up or down on both sides, and, therefore, join forces

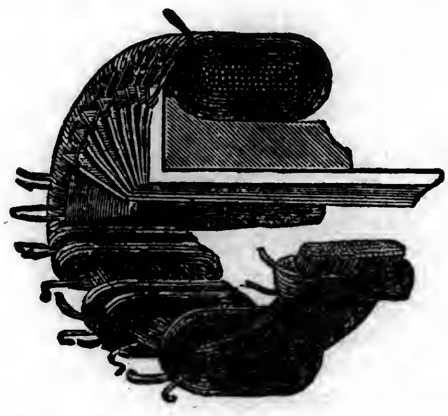


Fig. 11a.

at the upper or the lower brush. If, for instance, the coils are so wound that the current flows up in the coils on both sides, both currents will unite at the upper brush, where they will pass together into the outside wire or circuit, and thence through the outside circuit and back to the lower brush.

The very important fact will be observed that so long as the armature revolves, the current in the external circuit will never fall to zero as it did in the old Siemens machine, for the reason that though the current in each individual coil falls to zero twice in a revolution, yet the external current is the aggregate of all the currents produced by the coils, so that at the very instant when the current in one coil on each side is reduced to zero by reason of changing direction, there are other coils generating a strong current, so that the total current in the external circuit is merely reduced the proportional part due to one pair of coils. Therefore, the external current, though not perfectly continuous like that from a voltaic cell, has only a slight undulatory character very different from the throbbing Siemens current.

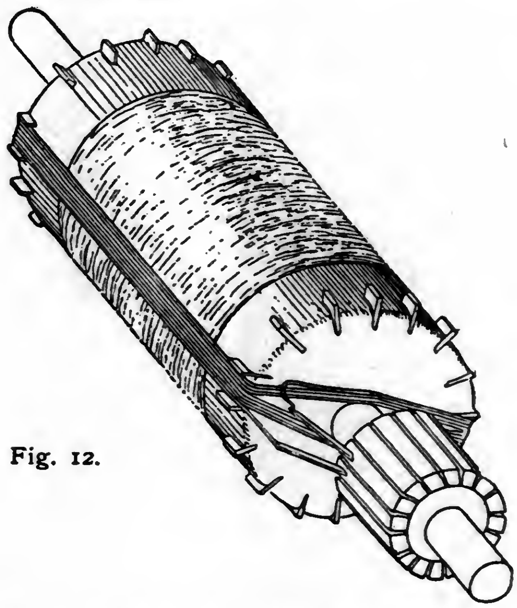


Fig. 12.

METHOD OF WINDING SIEMENS ARMATURE.

The superiority of the very constant current generated by the Gramme machine was so palpable that Siemens was not slow in appreciating it, and we soon find him bringing forward a machine in which, while the long armature is preserved, the single coil with its two-part commutator is replaced by a cylinder longitudinally wound with many coils which, like the Gramme coils, do not overlap each other but lie on different parts of the circumference, are connected to each other around the whole cir-

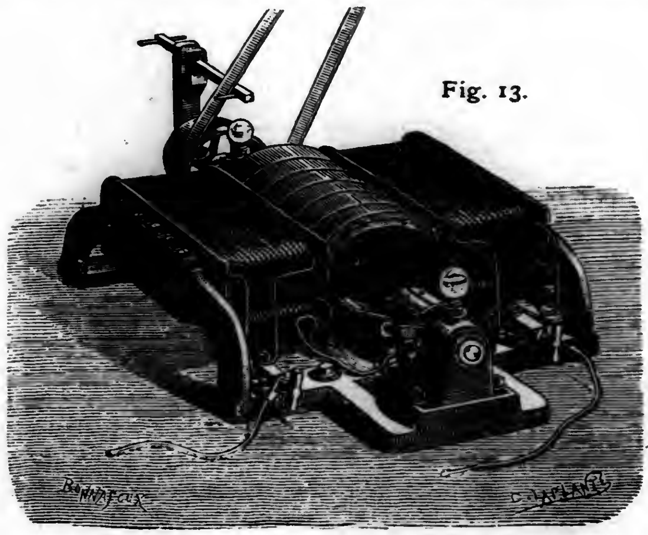


Fig. 13.

cumference, and are connected also to an equal number of brass strips secured to the armature shaft. Fig. 12 shows a new Siemens armature in process of construction, one coil only being in place, and fig. 13 shows a new Siemens machine, the armature with all its coils on, lying in position between the magnet poles.

In what has been said thus far, it has been assumed that

the field magnets were permanent magnets, or, at least, were not dependent for their magnetism upon the machine itself. Small dynamos are sometimes so made, and formerly all dynamos were; but now nearly all field magnets are electro-magnets produced and maintained by the armature revolving between their poles, as in fig. 14. When the armature is motionless, and therefore making no current, no magnetism is evident in the field magnets, except

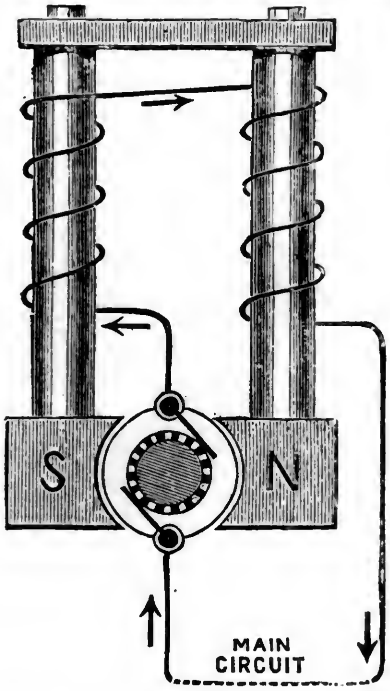


Fig. 14.

a trace of residual magnetism which always exists in a piece of iron that has once been magnetised. When the armature begins to turn, this residual magnetism causes a very slight current in the armature and, therefore, in the external wire, but since the wire is taken around the field magnets before leaving the machine, this slight current goes around the magnets and increases their magnetism. This increase causes a corresponding increase of current which in turn causes another increase of magnetism. These effects continue to react upon each other until the field magnets are "saturated" with as much magnetism as they will hold, and after this the current remains constant.

At the present day, nearly all the constant-current dynamos in the world are modifications—and some of them extremely slight modifications—of the Gramme and the new Siemens, but there is one, the Brush, which is quite original and which is at the same time very extensively used and very efficient and reliable.

In the Brush machine (fig. 15), separate coils, mounted as shown, are revolved rapidly between the poles of powerful magnets. Their action in cutting lines of magnetic force is, of course, precisely the same as that of coils in the Gramme and the Siemens machines, but the manner in which they are connected together and to the outside circuit is entirely different, for, instead of being connected in one series all around the armature and to metal strips lying side by side on the armature shaft, they are connected in pairs, each coil being connected to its opposite. For each pair of coils, there is a separate commutator on the axle, so that if there are eight coils, as shown in the figure, there are four commutators; and these commuta

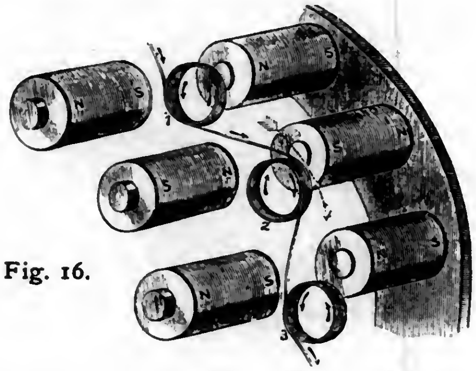


Fig. 16.

tors being arranged in pairs with one set of brushes to each pair there are two sets of brushes. The Brush machine is especially applicable to working a large number of street-lamps on one wire, the current generated being of a character capable of overcoming great resistance, or, as it is usually expressed, having high electromotive force.

We have thus far considered the means of generating currents constant in direction, but for quite a large fraction of the work that electric machines, or dynamos, are

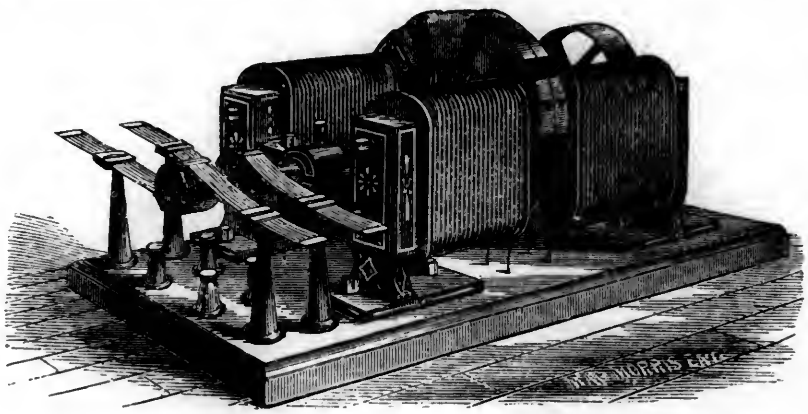


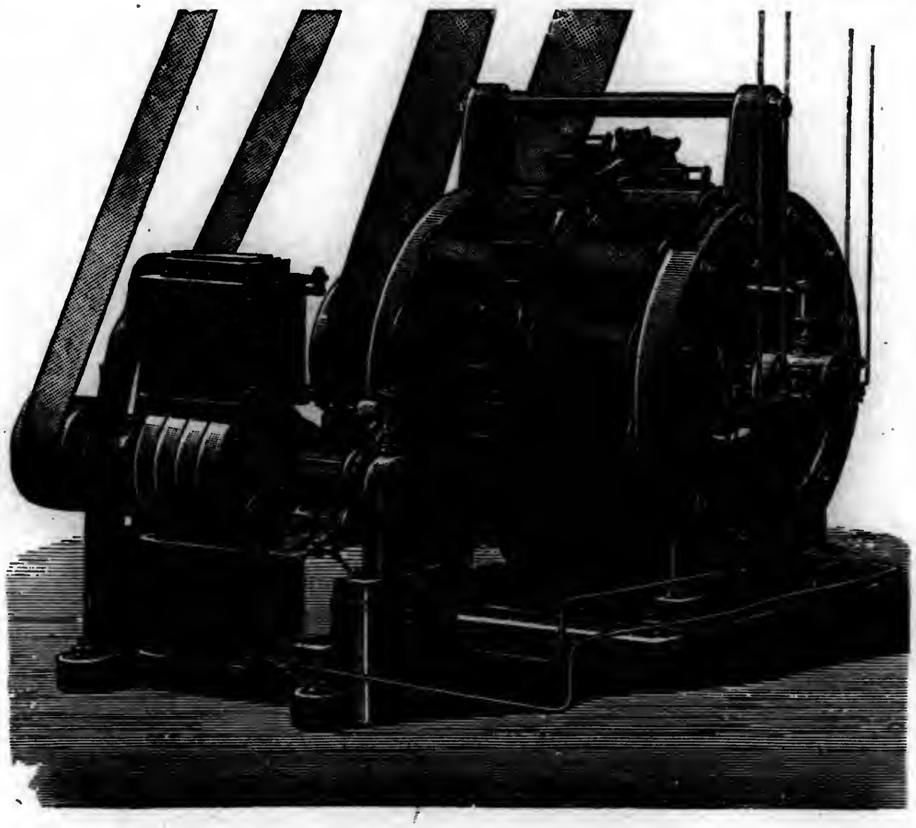
Fig. 15.

required to do, it is not necessary that the current be constant in direction, and in Europe machines giving alternating currents are used in great numbers for running the incandescent lamps employed in interiors, and some of these machines are very large and exceedingly efficient.

Alternate-current dynamos are, for the most part, based on the principle illustrated in fig. 8 (page 504), the ends being bodily transported from a field in which the lines of force run in one direction to a field in which they run in the opposite direction, the direction of current produced at any instant depending upon whether the lines of force are changing from negative to positive or from positive to negative. In constructing machines on this principle, a number of coils connected together but wound in opposite directions, as shown in fig. 16, are mounted so as to lie in the fields between the unlike poles of magnets,

Now, as the shaft rotates, these coils pass between the magnet poles in succession, and we can see that when any coil is approaching or receding from, say, a north pole, its two neighbors are approaching or receding from two south poles; so that contrary and opposing currents would be generated were it not for the fact that, as said above, alternate coils are wound in opposite directions, so that the currents induced in all the coils are added together and form one total current passing around all the coils in succession. But we also see that this current, passing in all the coils, changes in direction each time that the coils change position in the course of a revolution; so that if 20 coils revolve between the poles of 20 magnets, the current is changed 20 times per revolution. If the shaft revolved slowly, say once per second, the alternation would produce a vibrating light very unpleasant to the sight; but since the shaft revolves many times per second, the alternations succeed each other so rapidly that the eye is not quick enough to detect any change whatever, and the light appears perfectly steady. The field magnets, however, must be excited by a constant current, so that the poles will not change, and to accomplish this, it is usual to employ a small constant-current dynamo to send its current around the field magnets, as shown in fig. 17, representing a Siemens alternate-current dynamo, in which the coils are mounted in a shaft turned by a belt, and the field magnets are excited by a small Siemens constant-current machine standing in the foreground.

Fig. 17.



We now come to a system which has been used with considerable success abroad, and which is now being introduced into this country by the Westinghouse Company. It is called the "induction system." It was developed into a practical form mainly by the efforts of Messrs. Gaulard and Gibbs. To comprehend this system it will be necessary to recall Faraday's discovery of the generation of electric currents by the relative motion of coils and magnet poles, and also to remember that Faraday discovered, in addition, that similar effects could be produced if the magnets were electro-magnets, even if the iron coil were absent; and that they could be produced even if the electro-magnet and coils were stationary, but the current in the electro-magnet were made or broken or reversed, the explanation being simply that the number of lines of force embraced by the coil in question was changed not only by the motion of the magnet poles but also by any change in the strength of the magnet pole itself; in other words, that the number of lines of force embraced by a coil near a north pole could be lessened, not only by taking away the north pole but also by making the north pole cease to be a pole of any kind, by making it a south pole. In the light of these experiments, induction coils were constructed, in which two separate coils were wound on one coil, a battery being attached to one but not to the other; and it was seen that

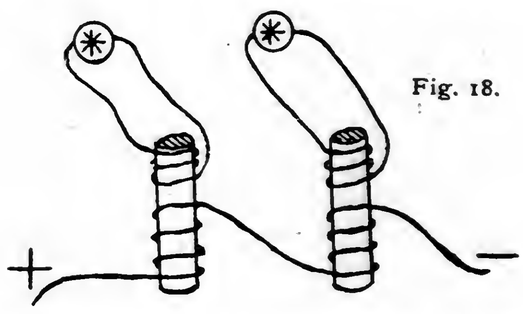


Fig. 18.

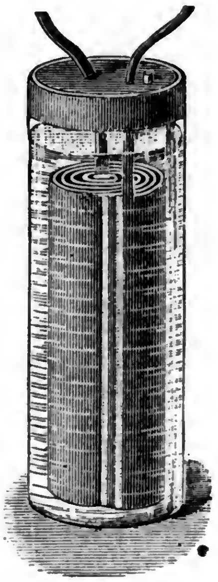
if the battery current were made or broken or reversed or changed in strength, a current called an "induced" current, would, at once, traverse the other coil.

The induction system of Messrs. Gaulard and Gibbs may be understood from fig. 18, in which the main current, which is alternating, goes along the heavy wire which is wrapped around such a piece of iron as shown in the figure, another wire in circuit with a lamp, or several

lamps, being also wound around each such piece of iron. The alternations of the main current induce currents in each of these circuits; but the main current itself does not enter them or any of the lamps. By this system it is possible to safely use a heavy alternating current of greater power than it would be wise to use if it fed the lamps direct, for the main current can pass at a safe distance from the lamps of a house, the induction coil being even outside.

Another system for furnishing electricity is by means of the secondary battery, or, as it is sometimes called, the "storage battery" or "accumulator," the prevailing idea being that it stores up or accumulates electricity that is put into it. The secondary battery is, however, merely a voltaic cell so composed that normally it yields no appreciable current, but which, when subjected to the action of a current of electricity generated by some outside source, is so changed chemically as to be able, after the removal of

Fig. 19.



this current, to give off a current of electricity itself in the opposite direction.

The secondary battery in its simplest form and as prepared by its inventor, Planté, consists of two plates of lead in a solution of dilute sulphuric acid. In order to get a considerable surface of lead, Planté rolls two plates (separated from each other, of course) into a cylinder, shown in fig. 19. Since both plates are exactly alike, or as nearly alike as possible, little or no current will pass from one plate to another if they are connected by a wire, but if a current be sent through from the outside source, a different state of things will soon be produced. The action of the current in the liquid (called electrolysis) is similar to that already mentioned in connection with the simple voltaic cell; it splits up the liquid, and the oxygen resulting goes to the plate by which the current enters and attacks it, forming brown per oxide of lead on its surface; while the hydrogen goes to the other plate, and, as it cannot attack this plate, there will soon be in the liquid two surfaces, peroxide of lead and pure lead, which are so different from each other that, after the exciting current has been removed, they will act exactly like the plates of copper and zinc in a simple voltaic cell and give off a current when connected by a wire, this current being opposite in direction to the electrolyzing current. Coincidently with the giving off of this current, the brown peroxide will begin to combine with the hydrogen which, as in the simple cell, goes to the negative pole, and the peroxide will gradually become monoxide, while the pure lead plate will be attacked by the oxygen set free and also become coated with monoxide of lead. The sulphuric acid then, attacking both plates, covers them with white sulphate of lead. Both plates being now brought to the same condition, the current will, of course, cease. The cell is then said to be "discharged." It is then again connected to the generator, and an outside current is again sent through but in the opposite direction from the the first one. This current has, of course, the effect of coating with brown peroxide of lead the plate to which the hydrogen went before, and of sending hydrogen to the plate formerly peroxidized, thus ensuring its reduction to pure lead again. The cell is then discharged, and then charged again in the same direction as at first, the successive chargings and dischargings causing the plates to be more and more eaten into by oxygen, so that eventually both become covered with a spongy layer possessing a very great amount of surface. When layers become sufficiently thick, the battery is said to be "formed"—and the process requires several months. It will be understood that, since the length of time during which the battery can furnish a current depends on the amount of peroxide, and since this depends on the amount of surface exposed, the advantage of the porous layers lies simply in the fact that they possess great surface.

In order to shorten the process of forming, M. Camille Faure conceived the idea of giving both plates a preliminary coating of red lead, which he made into a paste and attached to them, wrapping the plates then in parchment and in felt. Forming is then pursued as before, but since red lead is itself an oxide of lead, and as it is already in a finely divided condition, much less time is required to produce the desired state of things than when pure lead only is used as in Planté's cell.

Since Faure's invention, numberless secondary batteries have been devised, but they differ from Planté's and Faure's only in details of construction, the effort being mainly to reduce the weight of the cell and to support the plates in such a way that they can be in a finely divided condition and possess considerable surface, and yet not break to pieces in use. Secondary batteries are not yet as thoroughly perfected as some suppose, but they are rapidly improving and are coming into extensive use; and doubtless their future is great for many purposes where a dynamo can not conveniently be used, as for running street cars in crowded cities.

From the foregoing, it will be observed that, in order to obtain a current from a dynamo, it is first necessary to burn coal to produce steam, then to expand the steam in a cylinder to produce motion in a steam engine, then to connect the steam engine to a dynamo, which converts the energy of its mechanical motion into the electrical energy of a current. Now, each one of these processes is attended by considerable waste, so that the whole operation is not only complicated but is so extremely uneconomical that only about 10 per cent. of the energy of the burning coal is obtained in the current; and for this reason electricians have labored for years to get electricity from coal direct. Their starting point has been the discovery of Seebeck, that if the junctions of two metals be kept at different temperatures, a current will result; if for instance, a piece of copper (*k*, fig. 20) be placed as

shown on a block of bismuth, *a b*, and one junction, *b*, be heated while the other *a*, be kept cool, a small current will pass, as evidenced by the deflection of a pivoted magnet placed near. All the known metals have been tried, and numberless alloys, in the endeavor to produce a cell operated by heat alone, able to inexpensively generate currents sufficiently large to be of practical use for working lights and motors. One of the largest of these *thermo-electric* cells is Clamond's, in which the junctions are heated, of large blocks of alloy with sheets of iron. The products of combustion pass through flues which bring

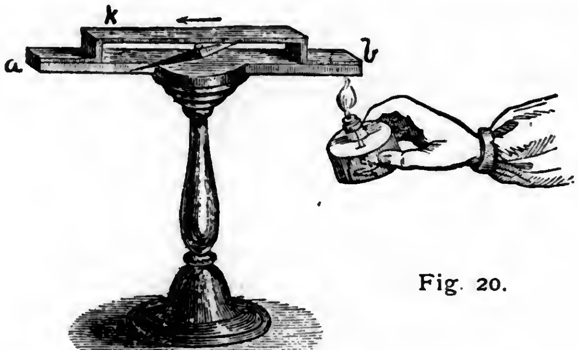


Fig. 20.

them into contact with one series of junctions, the other junctions being cooled by air. It is stated that, with this apparatus, a current has been generated strong enough to support an electric light of considerable power. A curious invention in this line is that of M. Brard, called an "electro-generative brick." The brick is made of prepared carbon, separated from nitrate of potash by a sheet of asbestos. A strip of brass is embedded in each, and the whole is enveloped in asbestos paper, the brass strips protruding. If the brick be now put into a hot fire, wires being attached to the two brass strips, a current, it is said, strong enough to ring a bell, will circulate in the wire, and continue for about two hours.

Though the act of producing electricity from heat direct cannot be said to have yet reached the practical stage, yet it is probably the method of the future; and though investigators are now groping in the dark, progress is surely though slowly being made, and at any time we may hear of the golden discovery which will render possible the safe, cheap, ready and abundant supply of electricity to the world.

RAILROAD ACCIDENTS IN GREAT BRITAIN.

THE report of the Board of Trade, just issued, gives the following summary of accidents and casualties reported to the Board as having occurred on the railroads of Great Britain and Ireland during the six months ending June 30, 1887:

I. ACCIDENTS TO TRAINS, ETC.

Accidents to trains, rolling-stock, permanent-way, etc., caused the death of 6 persons and injury to 241, as follows:

	1887.		1886.	
	Killed.	Injured.	Killed.	Injured.
Passengers	..	195	8	324
Servants of companies	6	46	3	40
Total	6	241	11	364

During the six months, there were reported 18 collisions between passenger trains or parts of passenger trains, by which 64 passengers and 9 servants were injured; 12 collisions between passenger trains and goods or mineral trains, etc., by which 76 passengers and 12 servants were injured; 7 collisions between goods trains or parts of goods trains, by which 2 servants were killed, and 2 cattle dealers and 13 servants were injured; 20 cases of passenger trains or parts of passenger trains leaving the rails, by which 1 servant was killed, and 14 passengers and 4 servants were injured; 4 cases of goods trains or parts of goods trains, engines, etc., leaving the rails, by which 3 servants were killed; 10 cases of trains running into stations or sidings at too high a speed, by which 20 passengers and 2 servants were injured; 54 cases of trains running over cattle (during the six months, 12 horses, 2 ponies, 34 beasts and cows, 62 sheep, 4 donkeys and 1 pig were run over and killed), or other obstructions on the line, by which 3 servants were injured; 2 failures of engine machinery, by which 2 servants were injured; 1 failure of brake apparatus, by which 15 passengers were injured; 2 failures of couplings, by which 1 passenger was injured; 3 slips in cuttings or embankments, by which 1 passenger and 1 servant were injured; and 1 other accident, by which 2 passengers were injured.

The following cases were also reported, but they involved no personal injury: 1 case of a train traveling in the wrong direction through points; 24 cases of trains running through gates at level crossings; 421 failures of tires; 127 failures of axles; 1 failure of a bridge; 132 broken rails; 1 case of flooding of the permanent-way; 3 fires on trains; and 2 fires at stations or involving injury to bridges or viaducts.

Of the 421 tires which failed, 7 were engine tires, 2 were tender tires, 4 were carriage tires, 16 were van tires, and 392 were wagon tires; of the wagons, 290 belonged to owners other than the railway companies; 361 tires were made of iron, and 60 of steel; 13 of the tires were fastened to their wheels by Gibson's patent method, 17 by Mansell's and 2 by Beattie's, none of which left their wheels when they failed; and 3 by other methods, one of which left its wheel when it failed; 21 tires broke at rivet-holes, 6 at the weld, 77 in the solid, and 317 split longitudinally or bulged.

Of the 127 axles which failed, 74 were engine axles, 68 crank or driving, and six leading or trailing; 11 were tender axles, 2 were carriage axles, 37 were wagon axles, and 3 were salt-van axles. Of the wagons 22, including the salt-vans, belonged to owners other than the railway companies. Of the 68 crank or driving axles, 41 were made of iron and 27 of steel. The average mileage of 40 crank or driving axles made of iron was 219,669 miles.

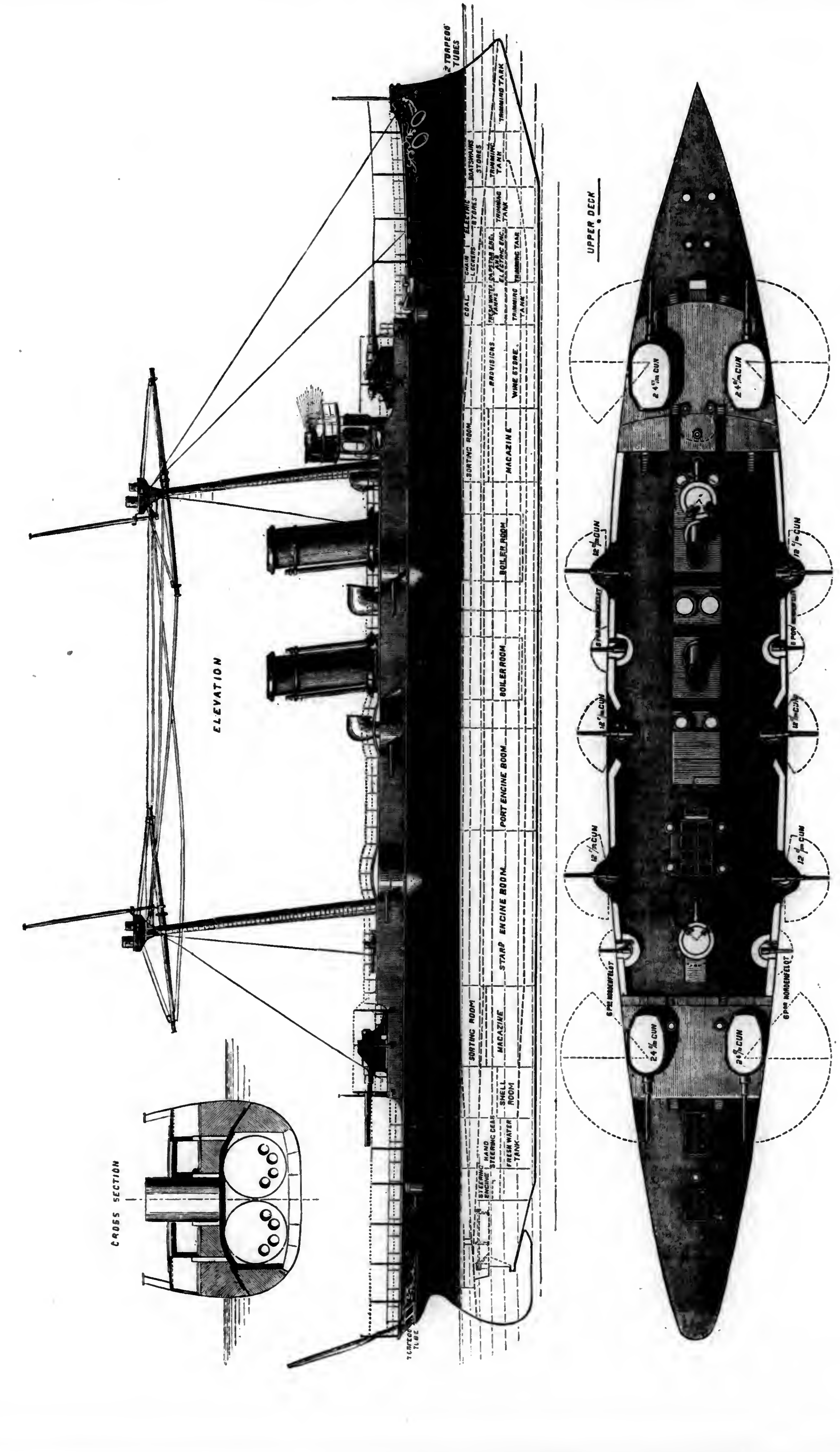
Of the 132 rails which broke, 53 were double-headed, 78 were single-headed, and one was of the bridge pattern; of the double-headed rails 29 had been turned; 22 rails were made of iron and 110 of steel.

II. ACCIDENTS TO PERSONS NOT EMPLOYES.

Of the 194 persons killed and 429 injured in this division, 42 of the killed and 331 of the injured were passengers. Of the latter, 10 were killed and 14 injured by falling between carriages and platforms, 6 being killed and 7 injured when getting into, and 4 killed and 7 injured when alighting from trains; 7 were killed and 232 injured by falling on to platforms, ballast, etc., 1 being killed and 27 injured when getting into, and 6 killed and 205 injured when alighting from trains; 11 were killed and 9 injured whilst passing over the line at stations; 37 were injured by the closing of carriage doors; 1 was killed and 7 were injured by falling out of carriages during the traveling of trains; and 13 were killed and 32 injured from other causes. There were 26 persons killed and 14 injured whilst passing over railways at level-crossings, 12 being killed and 11 injured at public level-crossings, 9 killed and 3 injured at occupation crossings, and 5 killed at foot crossings. There were 79 persons killed and 46 injured when trespassing on the railways; 32 persons committed suicide on railways; and of other persons not specifically classed, but mostly private people having business on the companies' premises, 15 were killed and 38 injured.

III. ACCIDENTS TO EMPLOYES.

During the six months, there were 214 servants of companies or contractors reported as having been killed and 920 injured, in addition to those included in Division 1. Of these, 20 were killed and 109 injured while coup-



CRUISER "REINA REGENTE" FOR THE SPANISH GOVERNMENT.

BUILT BY J. G. THOMSON, CLYDEBANK, SCOTLAND.

ling or uncoupling vehicles; 2 were killed and 12 injured by coming in contact, whilst riding on vehicles during shunting with other vehicles, etc., standing on adjacent lines; 2 were injured whilst riding, passing over or standing upon buffers during shunting; 11 were killed and 72 injured in getting on or off, or by falling off engines, wagons, etc., during shunting; 3 were killed and 49 injured whilst breaking spragging or chocking wheels; 6 were killed and 38 injured whilst attending to ground-points, marshaling trains, etc.; 3 were killed and 90 injured whilst moving vehicles by capstans, turn-tables, props, etc., during shunting; and 16 were killed and 169 injured by various other accidents during shunting operations; 9 were killed and 34 injured by falling off engines, etc., during the traveling of trains; 2 were killed and 8 injured by coming in contact with over-bridges or erections on the sides of the line during the traveling of trains; 6 were killed and 45 injured whilst getting on or off engines, vans, etc., during the traveling of trains; 4 were killed and 73 injured whilst attending to, or by the failure of, machinery, etc., of engines in steam; 62 were killed and 58 injured whilst working on the permanent-way, sidings, etc.; 2 were injured whilst attending to level crossing gates; 45 were killed and 58 injured whilst walking, crossing or standing on the line on duty; 3 were killed and 22 injured by being caught between vehicles; 4 were killed and 21 injured by falling or being caught between trains and platforms, walls, etc.; 18 were killed and 14 injured whilst walking, etc., on the line on the way home or to work; and 44 were injured from various other causes.

SUMMARY.

Altogether, the number of persons killed and injured on railways in the United Kingdom in the course of public traffic during the six months ending June 30, as reported to the Board of Trade, was as follows:

	1887.		1886.	
	Killed.	Injured.	Killed.	Injured.
Passengers:				
From accidents to trains, rolling stock, permanent-way, etc....	..	195	8	324
By accidents from other causes	42	331	43	303
Servants of companies or contractors:				
From accidents to trains, rolling stock, permanent-way, etc....	6	46	3	40
By accidents from other causes.	214	920	169	918
Persons at level-crossings.......	26	14	39	17
Trespassers (including suicides).	111	46	134	42
All persons not classed above...	15	38	23	42
Total..................	414	1,590	449	1,686

IV. MISCELLANEOUS ACCIDENTS.

In addition to the above, the railway companies have reported to the Board of Trade, in pursuance of Section 6 of the Regulation of Railways Act, 1871, the following accidents which occurred upon their premises, but in which the movement of vehicles used exclusively upon railways was not concerned, namely: 2 passengers killed and 69 injured whilst ascending or descending steps at stations; 10 injured by being struck by barrows, falling over packages, etc., on station platforms; 16 injured by falling off platforms; and 1 killed and 35 injured from other causes. Of servants of companies or contractors 433 injured whilst loading, unloading or sheeting wagons; 1 killed and 126 injured whilst moving or carrying goods in warehouses, etc.; 1 killed and 74 injured whilst working at cranes or capstans; 1 killed and 156 injured by the falling of wagon doors, lamps, bales of goods, etc.; 182 injured by falling off, or when getting on or off stationary engines or vehicles; 4 killed and 125 injured by falling off platforms, ladders, scaffolds, etc.; 1 killed and 110 injured by stumbling whilst walking on the line or platforms; 93 injured whilst attending to stationary engines in sheds; 24 injured by being trampled on or kicked by horses; 2 killed and 238 injured whilst working on the line or in sidings; and 1 killed and 128 injured from various other causes. Of other persons, most of whom were transacting business on the companies' premises, 7 were killed and 82 injured, making a total in this class of accidents of 21 persons killed and 1,901 injured.

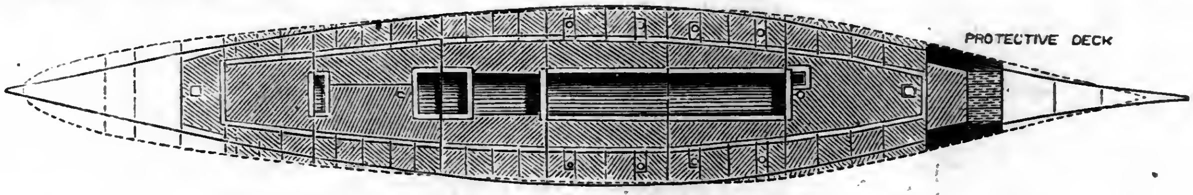
Thus the total number of personal accidents reported to the Board of Trade by several railway companies during the six months amounts to 435 persons killed and 3,491 injured.

The Spanish Cruiser "Reina Regente."

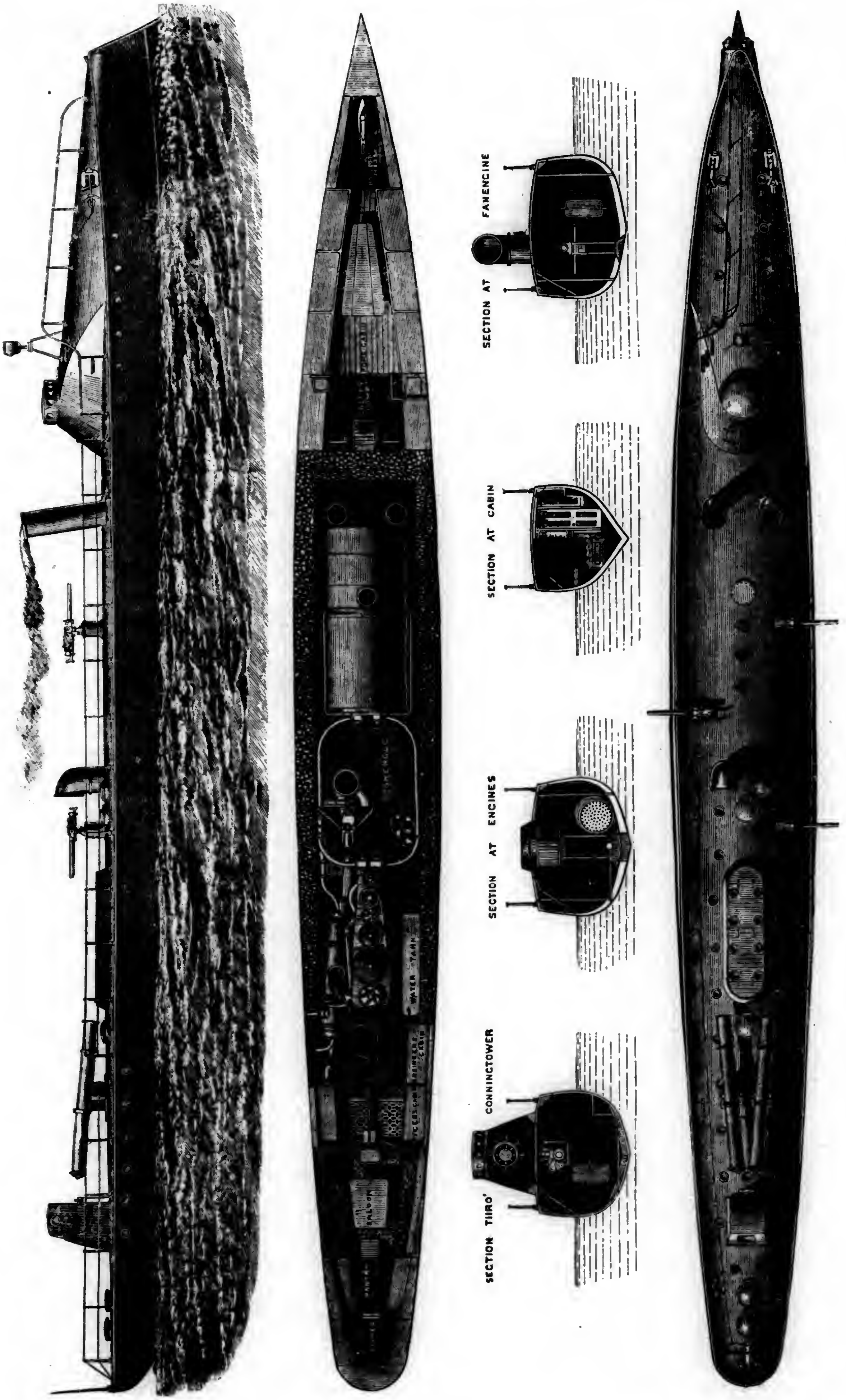
(From the London *Engineer*.)

THE accompanying engravings show the salient points of the new cruiser *Reina Regente* recently completed by Messrs. Thomson, of Clydebank, for the Spanish Government.

The principal dimensions are as follows: Length on water line 317 ft.; breadth, 50 ft. 7 in.; depth, molded, 32 ft. 6 in.; normal displacement, 4,800 tons; deep load displacement, 5,600 tons. This vessel was designed by Messrs. Thomson in competition with several other shipbuilding firms of this and other countries, in reply to an invitation of the Spanish Government for a cruiser of the first class. The design submitted by the builders of the *Reina Regente* was accepted, and the vessel was contracted to be built in June of last year. The principal conditions of the contract were as follows: The ship to steam at a speed of 20½ knots for four runs on the mile, and for two hours continuously afterward. She was further to be capable of steaming for six hours continuously at a speed of 18½ knots, without any artificial means of producing draft. She was also to be capable of steaming a distance of at least 5,700 knots for 500 tons of coal, at some speed over 10 knots, to be chosen by the builders. Over the length of her machinery and magazine spaces she was to have a sloping deck extending to 6 ft. below the water-line at the side, and formed of plates 4¾ in. thick. This deck was to extend to about 1 ft. above the water-line, and the flat part to be 3⅛ in. thick. Beyond the machinery and magazine spaces, the deck was to be gradually reduced to 3 in. thick at the ends. This deck is intended to protect the vitals of the ship, such as boilers, engines, powder magazines, steering gear, etc., from the effects of shot and shell, but the floating and stability-maintaining power of the ship was to be dependent upon a similar structure raised above this protective deck to a height of about 5 ft. above the water. This structure is covered by a water-tight deck, known as the main deck of the ship, on which the cabins and living spaces are arranged. The space between the main and protective deck is divided, as may be seen by reference to the protective-deck plan, into many strong, water-tight spaces, most of which are not more than about 500 ft. capacity. The spaces next to the ship's side are principally coal bunkers, and may, therefore, exclude largely any water that should enter. The first line of defense is formed inside these coal bunkers by a complete girdle of cofferdams, which can be worked from the main deck. These it is intended to fill with water and cellulose material, and as they are also minutely sub-divided, the effects of damage by shot and consequent flooding may be localized to a considerable extent. The guns of the ship are to consist of four 20-centimeter Hontorio breech-loading guns on Vavasseur carriages, six 12-centimetre



PROTECTIVE DECK PLAN.



TORPEDO BOAT FOR THE SPANISH GOVERNMENT.

BUILT BY YARROW & CO., LONDON, ENGLAND.

guns, eight 6-pounder rapid firing, and eight or ten small guns for boats and mitrailleuse purposes, four of which are in the crow's-nests at the top of the two masts of the ship. We may remark in passing that the builders saw their way at an early period of the construction to suggest an addition to the weight of the large-sized guns, and there will actually be on the ship four 24-centimeter guns instead of four 20-centimeter. The vessel was to carry five torpedo tubes, two forward in the bow, one in each broadside, and one aft; all these tubes to be fixed. To fulfill the speed condition, four boilers were necessary and two sets of triple-expansion engines, capable of developing in all 12,000 H. P.

Now that the vessel has been completely tried, the promises by the builders may be compared with the results determined by the Commission of Spanish officers appointed by the Government of Spain to say whether the vessel fulfilled in all respects the conditions laid down in the contract. The mean speed attained for the two hours' run was 20.6 knots, as compared with 20.5 guaranteed, but this speed was obtained with 11,500 H. P. instead of the 12,000 which the machinery is capable of developing. The officers of the Spanish Commission were anxious not to have the vessel's machinery pressed beyond what was necessary to fulfill the speed conditions of the contract; but they saw enough to warrant them in expressing their belief that the vessel can easily do twenty-one knots when required, and she actually did this for some time during the trial. During the natural-draft trial the vessel obtained a mean speed of 18.68 knots, on an average of 94¾ revolutions—the forced draft having been done on an average of 105½ revolutions. The consumption trial, which lasted 12 hours, was made to determine the radius of action, when the ship showed that at a speed of 11.6 knots she could steam a distance of 5,900 knots. Further trials took place to test the evolutionary powers of the vessel, though these trials were not specified in the contract.

The vessel, as may be seen from the engravings, is fitted with a rudder of a new type, known as Thomson & Biles' rudder, with which it is claimed that all the advantage of a balanced rudder is obtained, while the ship loses the length due to the adoption of such a rudder. It is formed in the shape of the hull of the vessel, and as the partial balance of the lower foreside gradually reduces the strains, the rudder-head may be made of very great service. As a matter of fact this rudder is 230 ft. in area, and is probably the largest rudder fitted to a warship. The efficiency of it was shown in the turning trials, by its being able to bring the vessel round, when going at about 19 knots, in half a circle in 1 minute 23 seconds, and a complete circle in 2 minutes 55 seconds, the diameter of the circle being 350 yards. This result, we believe, is unrivalled, and makes this vessel equal in turning capabilities to many recent warships not much more than half her length.

The New Spanish Torpedo-Boats.

(From the London *Engineering*.)

THE accompanying engravings are illustrations of two torpedo-boats, the *Azor* and the *Halcon*, which have lately been built for the Spanish Government by Messrs. Yarrow & Co., of Poplar.

These boats are exactly alike in all respects; they are 135 ft. long by 14 ft. beam, being of the same general dimensions as the No. 80 torpedo-boat, lately completed by the same firm for the Admiralty, which is the largest and fastest torpedo-boat in the British Navy.

The general arrangement of these boats is so well shown in the illustrations as to need but little description. The engines are of the triple-compound type, capable of indicating 1,550 H. P., steam being supplied by one large locomotive boiler, which is in accordance with the usual practice of the makers; as, by using a single boiler, great simplification of the machinery is secured, and less room is occupied than if two boilers were used. While in some torpedo boats there has been trouble with the locomotive type of boiler, it is a fact that Yarrow & Co. have already constructed a great number of locomotive boilers of the exceptional size adopted in these Spanish boats, and they have turned out perfectly satisfactory in every respect in actual service.

The forward part of the boat is provided with two torpedo-ejecting tubes, as usual; near the stern, on deck, it is proposed to erect turn-tables, with two torpedo-guns for firing over the sides, a plan already adopted by several governments.

The trials of the *Azor* took place about two months ago, giving a speed during a run of 2¾ hours of 24 knots an hour, with a load of 17 tons on board. Since her trial she has steamed out to Spain, having met during a portion of the voyage with very bad weather, when her sea-going qualities were found to be admirable.

The *Halcon*, whose official trials took place recently, obtained a speed of 23.5 knots an hour, carrying a load of 17 tons. She is now being pushed forward to completion, and will leave for Spain in a week or two. It may be remarked that a speed of 24 knots in a boat only 135 ft. long, under the Spanish conditions of trial, is by far the best result that has ever been attained in a vessel of these dimensions. There is, however, no doubt that a still higher speed would have been obtained, had the length of the boat been greater; but the authorities desired to keep within the smallest possible dimensions, so as to expose as small an area as practicable to the fire of an enemy, it being clearly evident that this is a consideration of the first importance in an unprotected war vessel.

In conclusion, we would add that the hulls of these two Spanish boats are of much greater strength of construction than is usually adopted in torpedo-boats, it having been found that strength sufficient for actual service has often been injudiciously sacrificed for the sake of obtaining exceptional speeds. Judging from the numerous accidents which took place at the recent trials off Portland, we have no doubt that in the future our naval authorities will be quite ready and willing to sacrifice a little speed to obtain vessels which are most trustworthy. The necessity for this, we are convinced, will be conclusively shown, if ever torpedo-boats are engaged in actual warfare, not only as regards strength of hull, but also as regards the machinery.

It must be admitted that the engines and other machinery at present used in this class of boats can only be handled successfully by men of exceptional skill and training; and in time of war such men could not readily be procured.

THE NEW AND THE OLD NAVY.

WE give below in condensed form a number of notes from various sources in relation to the new ships and guns for the Navy, and other naval matters:

THE NEW TORPEDO-BOAT.

The bids for the construction of a new torpedo-boat were opened at the Navy Department, November 1. The bids were two in number, one from the Vulcan Iron Works, of Chicago, at $84,800, the other from the Herreshoff Manufacturing Company, of Bristol, R. I., at $82,750.

This vessel is to be of the best and most modern design; to be constructed of domestic steel, and to have the highest attainable speed. Premiums will be paid at the rate of $1,500 for each quarter knot in excess of 23 knots, and including 24 knots; $2,000 for each quarter knot in excess of 24 knots. Should the speed fall below 22 knots a penalty of $4,000 will be enacted, and if below 20 knots the Department reserves the right to reject the boat. The trial is to consist of a continuous run of three hours' duration in smooth water.

The approximate length of the boat is 135 ft.; beam, 15 ft.; depth under spar deck, 6 ft. 2 in.; draft forward, 2 ft.; aft, 5 ft. 2 in.; displacement at load water line, about 100 tons. It is to have a ram bow, and the stern is to be adapted to twin screws. The deck is to be elliptically curved, and is to have a maximum rise of not more than

2 ft. 4 in. at the greatest breadth of beam. There are to be two conning towers, placed approximately 30 ft. from the bow and 30 ft. from the stern respectively. From the forward conning tower to the stem of the boat the deck is to assume the form of a whale-back, so as to completely enclose and cover two torpedo-launching tubes. The main engines are to consist of two sets of compound triple-expansion condensing engines, with direct connection to propeller-shafts, with separate engines for working the circulating and air pumps.

COAST DEFENSE.

As noted last month, the Naval Board on Coast Defense has nearly completed its report. As then indicated this report will recommend a system of defense consisting of monitors supported by auxiliary craft, such as rams and torpedo-boats. The Board has found that the $2,000,000 appropriated by Congress for this purpose will be sufficient to establish at least one unit of the system. The monitor *Miantonomoh* has been selected as the vessel which will be center of the unit, and she will be aided with several fleet rams which in turn will be accompanied and protected by small, speedy torpedo-boats and fish torpedoes. If this unit should be found to work harmoniously and efficiently the system can be indefinitely extended from year to year without requiring a great expenditure at one time.

One important point, remaining unsettled, however, concerns the auxiliary craft. The rams brought before the Board are of two general classes. The first class is a type of heavy ram intended to crush in the side of a ship by a powerful blow. The second class, which meets with more favorable consideration at the hands of the Board, includes what is known as the Berdan system. These rams are double-ended, have ferryboat bows, so as to prevent the submarine ram from being twisted off when an enemy is struck at an angle, and being equipped with propellors at each end are capable of turning as on a pivot. They are also equipped with diving torpedoes attached to cables, so as to swing up and explode beneath a vessels bottom, regardless of the net now relied upon as a protection against torpedoes.

THE NEW CRUISERS.

Work on the *Charleston* at the Union Iron Works in San Francisco is now well advanced. The vessel is framed and has received the outside plating up to the protective deck, and the water-tight bulkheads have been put in the hull.

The material for cruiser No. 5, which is to be built at the same yard, has been ordered, and work will soon be begun.

NAVAL ORDNANCE.

The Chief of the Naval Bureau of Ordnance, Commodore Montgomery Sicard, presents the following estimates for the fiscal year ending June 30, 1889: General expenses, $1,122,225; toward the armament of vessels authorized, $2,000,000. Of the cannon for the *Chicago*, *Boston*, *Atlanta* and *Dolphin*, there remain incomplete but six, which will all be completed in a few months. Contracts have been made for 78 other forgings for the 6-in. gun, 4 for the 8-in., 24 for the 10 in. and 2 for the 12-in. Those for the 6-in. are beginning to come in and will be taken in hand at once. The Bethlehem Iron Company will be prepared to deliver by August 1, 1888, when it is expected that the supply for large and small forgings will be ample. The 6-in. and 8-in. calibers have stood satisfactorily and statutory test for guns, carriages, and equipments, 10 rounds for each caliber.

The guns of the *Atlanta* and *Boston* have been, besides, fired a large number of times in ranging and in practical tests, etc. No defects have been developed. The two 8-in. guns of the *Boston* have been finished and proved. They are hooped to the muzzle, and are fine specimens of work. The 8-in. guns of the *Chicago* are being machined by the South Boston Iron Works and by the West Point Foundry Association, two at each place. One 10-in. gun has been finished and mounted for proof; another is nearly finished, and a third has been commenced at the Washington yard, from 10½-in. English forgings, intended for the *Puritan*.

The Duponts have not yet fully succeeded in developing a powder suitable for use in the chamber of the 8-in. gun, though they have submitted a sample from which an order has been given for a supply for the 8-in. guns of the *Boston* and *Chicago*. There is also a supply for a trial of the 10-in. gun as soon as it is mounted and no serious trouble in obtaining powder for the 10-in. gun is anticipated. No deterioration in the American brown powder has been noticed thus far, and it is hoped it may prove to have good keeping qualities, though a greater length of time and service is necessary in order to settle this.

The manufacture of cast-iron projectiles continues, but little or no success has attended the attempt to secure those of cast-steel, nearly all the castings being more or less porous. A few armor-piercing shells have been purchased from the St. Chamond Company in France. The Chrome Steel Company, of Brooklyn, N. Y., has made a number of very good 6-in. armor-piercing shell forgings, but those attempted for the 8-in. were not so good. It is hoped that other attempts will be more successful.

The bid for steel cast guns has not been acted on. The report refers to the establishment of a factory for making Hotchkiss guns in this country; also to the necessity of more money for the armament of the new ships.

At the Washington gun factory, the foundations for the 40-ton crane supports have been mostly laid.

The excavation for the foundation of the large gun shop is three-fourths completed, and the material for its construction has been advertised for and some of it delivered.

The traveling cranes are advertised for, and the machine tools will be speedily.

The naval proving ground has continued to do satisfactory work, and more money is needed for it. No success has thus far attended the selection of a new site. The ground is preparing for the test of the Clark deflective target. The neighborhood of the town and other buildings and the proximity of two lighthouses to the range make it necessary to provide very fully for the confinement of the shot within the shelter to be erected about the target. Great care will be observed in this matter, and it is thought that no danger will ensue from the trial.

Many plans and designs of torpedoes have been submitted, and some are under examination and trial. There is much need of a special vessel, which could be used both for experimental purposes and as a training ship.

THE GENERAL CONDITION OF THE NAVY.

In his annual report to the Secretary of the Navy, Admiral Porter points out various defects in the navy regulations which render them in some cases almost unintelligible, and suggests that a board be created to revise them. He alludes to the high ability necessary for officers of the Engineer Corps, on which depends the efficiency of ships of war, and regards it as hardly within the bounds of possibility that any one man can be a good line officer, engineer and marine officer. No man can gain a sufficient knowledge of the nautical part of his profession by passing half of his time in the engine-room and the other half on deck. The Admiral says it would be as difficult efficiently to combine the duties of line officer and engineer as to mix oil and water, and holds that the education of an engineer can only be secured by special training.

In considering the question of coast defenses, the Admiral states that the following harbors are entirely defenseless against a single iron-clad: New-York, Boston, San Francisco, lake ports, Hampton Roads and Norfolk, New Orleans, Philadelphia, Washington, Baltimore, Portland, Me., Rhode Island ports, Key West, Charleston, Mobile, Savannah, Galveston, Pensacola, Wilmington, N. C., San Diego, Cal., Portsmouth, N. H., to say nothing of many other places of greater or less importance. Two heavy iron-clads could begin at the easternmost point and proceed along the coast to Texas, having them all under contribution. In time of war, says the Admiral, the torpedo system will be useless for defense in the absence of proper fortifications and guns. For the event of war

we are no more prepared than we were a year ago, although we have made a beginning simply to repair the waste in our navy for the past 25 years. In the opinion of the Admiral, the first step toward the protection of the coast should be the construction of a squadron of heavy iron-clads that could be ready at a week's notice to anchor off shore and resist an approaching enemy. If defeated, this force could retire to the protection of the forts, where, united, they could offer more than twice the resistance they could offer singly. The Admiral argues at length in favor of subsidies for shipping, and points to the success of the system in England, Germany and France.

Touching the *personnel* of the Navy, he says it requires the most careful re-organization, and means should be adopted to infuse new life into it. As regards promotion, the service is at a standstill. Many officers who are Ensigns should be Lieutenants, Lieutenants should be Lieutenant-Commanders, the latter should be Commanders, and Commanders, Captains. A Captain should be able to reach the grade of Rear-Admiral by the time he attains the age of 52 years, so that the Government could obtain some service from him in that grade. Under present circumstances it often happens that an officer goes upon the retired list as soon as he is promoted to the grade of Rear-Admiral, having attained the age of 62 years. No officers should be over 40 years of age when commissioned a Captain or 35 when promoted Commander. The officers in the lower grades should be young men in robust health, active and energetic, to enable them to perform the varied duties of their profession, and should not be allowed to remain too long without promotion. A law providing that commissioned officers of the Navy, with good records, be allowed to retire from active duty after 30 years' service, with promotion to the next higher grade, would afford a great relief and help bring about a more rapid promotion, so that in the course of a few years we might expect to see a more hopeful feeling among the younger officers. The older ones have the goal of their ambition in sight and may hope ultimately to reach it, but to the youngers ones, at the present time, the prospect is not cheering. Some of the more aspiring are seeking in private employment the advancement they fail to receive in the Navy.

THE OLD NAVY.

Commodore T. D. Wilson, Chief of the Bureau of Construction and Repairs, has submitted his annual report to the Secretary of the Navy. In view of the additional duties devolving upon the Bureau in connection with the designing and building of new vessels, he asks that an Assistant Chief of the Bureau be authorized by law. He renews his recommendation that two new vessels of about 1,000 tons each be built to replace the training ships *Saratoga*, *Jamestown* and *Portsmouth*, which cannot possibly be kept in service much longer, and he asks that special authority be given for the repair of the historic sloop-of-war *Hartford* at a cost of $175,000. Relative to the adaptability of the single-turreted monitors to coast and harbor defense, Commodore Wilson says :

"They are now a considerable expense to the Navy, as they must be taken care of, and, not being in proper repair, they are of no use to the country. If these vessels are to be kept on the naval list they should be placed in perfect repair and be fitted with such modern rifles as they are capable of carrying. Within six months all of these vessels could be put into the same state of efficiency as they were at the time of their construction at an expenditure of about $500,000. This would give 13 coast-defense vessels actually available, armed with 15-in. smooth-bore guns. These guns could be replaced as rapidly as possible by rifles. By no other means could the same amount of money be spent to give the country such a valuable return."

Tables attached to the report show the exact condition of every vessel in the Navy. Of the wooden vessels it is said : "The *Trenton*, launched in 1876, represents the latest and best type of wooden steam cruiser, and will be useful and valuable as a cruiser for several years to come. With the *Omaha* and *Vandalia*, second-rates, she can probably be continued in the service nine years longer; the *Lancaster*, with new boilers, six years; the *Brooklyn* and *Richmond*, five years, and the *Pensacola*, three years. Of the third-rates the *Mohican* can be continued in service nine years; the *Adams*, *Alliance*, *Essex*, *Kearsarge*, *Enterprise*, *Tallapoosa*, *Yantic* and *Nipsic*, for five years; the *Juniata*, *Ossipee*, *Swatara*, *Galena* and *Marion*, four years longer. The *Quinnebaug* and *Iroquois* will probably be condemned by law on survey. It will thus be seen that in three years we shall have 21 of these vessels remaining, in six years only 4, and in nine years the entire wooden navy will have dissappeared.

COAST DEFENSES OF THE UNITED STATES.

Two important official documents bearing on the queston of Coast Defense have been recently submitted. Both are given in a condensed summary below:

THE ENGINEER CORPS.

The annual report of General Duane, Chief of Engineers, to the Secretary of War, shows that the number of officers in the corps at the end of the last fiscal year was 109. Beyond reference to the attached reports of officers in charge of improvements, the subject of river and harbor improvements receives little mention in the report, which is largely devoted to a statement of the condition of sea-coast and lake-front defenses. On this topic General Duane says that many of the works are dilapidated, and economy requires that they should be kept from decay. Special attention is invited to the estimates for the protection of Fort Niagara, N. Y., which is regarded as of great value to the military service. The estimates submitted aggregate $5,234,000, including $2,840,000 for the construction of gun and mortar batteries, $175,000 for protection, preservation and repair of fortifications, $1,860,000 for submarine mines and appliances for closing channels, and $30,000 for torpedo experiments. In a report upon the subject of fortification made by the Board of Engineers, which is included in General Duane's report, it is said :

"It must be evident that immediate action is demanded to place our sea-coast defenses in proper condition to resist the attacks of an enemy. From the differences of opinion which exist among certain non-military experts as to the character of armor to be used in land defenses, the impression has been created that this matter is an unsettled and tentative condition and that the policy of inaction now existing should still continue. But the facts will not warrant this conclusion, as more than nine-tenths of the armament recommended for our sea-coast is not to be mounted behind iron protections, but in the rear of earthen covers surmounting and shielding the masonry, magazines bomb-proofs and store rooms. Particularly is this true of the rifled mortars, which must hereafter play an important part in the defense of our channels and fair ways, and there is no reason why the erection of the batteries required for them should be delayed a single month. In a word, proper sums may be judiciously expended and much progress toward placing our coasts in a defensive condition may be made—indeed, must be made—before the question of armor demands consideration."

In accordance with the instructions of the Secretary of War the Board has also submitted preliminary plans for the defense of the most important sea-board harbors. On this point it says: "No iron armor is estimated for because more extended defenses can be obtained by investing the funds in other preparations equally necessary and less costly. Such works are mortar batteries and disappearing gun batteries, lifts and the casemates, shafts and galleries needful to establish a defense by submarine mines." Two typical designs prepared by the Board, which are said to meet all modern requirements, are for fortifications constructed of sand, covering the masonry and bomb-proofs. The report says that no armor is now or ever will be required for such defenses. It is believed that disappearing carriages can be constructed which will carry 12-in., 50-ton rifled guns, and an appropriation is suggested sufficient to place a few of these guns and carriages at each of the principal ports. The plan of defense by mortar and gun

batteries recommended by the Board involves an expenditure during the next fiscal year of $2,840,000, which it is proposed to divide among the ports as follows: New-York, $690,000; San Francisco, $460,000; Boston, $280,000; Hampton Roads, $250,000; New-Orleans, $210,000; Philadelphia, $210,000; Washington, $80,000; Baltimore, $60,000; Portland, $290,000; Narragansett Bay, $290,000. The plan also contemplates the preparation of casements, cable shafts, etc., to the number of 26, distributed as follows: At New York, 5; at San Francisco, 5; at Boston, 5; at Hampton, 2; at Philadelphia, 2; at Washington, 1; at Baltimore, 1; at Portland, 3; at Narragansett Bay, 2.

THE ORDNANCE DEPARTMENT.

General Benet, Chief of Ordnance for the Army, in his annual report shows his expenditures for the year to have been $1,597,652. In addition to the regular estimates he asks for the coming year $1,500,000 for steel-gun forgings and $550,000 for the development of the present Government plant into properly equipped shops adequate for manufacturing guns in quantity, $500,000 for 12-in. rifled mortars, and an appropriation to test some different types of mortar carriages. "This question is one of great urgency and should not be postponed any longer from the want of money to investigate it. The same is equally true as regards the general subject of gun carriages. Experimental types should at once be procured and tested for the different calibers of steel sea-coast guns, and standard types adopted. More stress is laid on mortar carriages, simply for the reason that is very probable that we shall have mortars ready for mounting before we have guns. But for either class of piece, considerable time will be required for establishing the details of construction of a properly constituted carriage." The manufacture of an improved limber, caisson, battery wagon and forge for the new field-guns is to commence at once for issue and trial, and $225,000 is asked for the purchase of steel guns, their carriages and ammunition. This will procure not less than 60 steel guns, fully equipped and supplied with ammunition; or taking the 3.2 in. guns now on hand and under manufacture into consideration, it should ensure the full and proper equipment of 100 field guns.

An account is given of the trial of the 8-in. breech-loading steel rifle, which has been fired 100 rounds without erosion or appreciable enlargement. The ballistic results, that is to say, the energy developed in the projectile, exceed the published results of any gun of like caliber extant. As regards accuracy, so far as that has been tested, it was ascertained, as stated in my last report, that for a range of 3,000 yards, or nearly 1¾ miles, the shooting was as follows: Target 30 by 40 ft.; Mean vertical deviation from center of impact, 1.90 ft.; mean horizontal deviation, 1.56 ft.; mean deviation, 2.46 ft.; or the centers of all the shot holes were contained within a circle of 6½ ft. diameter.

An account is given of the concentration of gun plant at Watervliet, and of the controversy with the South Boston Iron Works, touching the present right of possession of two lathes and one traveling crane, the property of the United States at the South Boston Foundry.

The status of the work on the manufacture of the several experimental guns is about as follows: The casting of the 12-in. breech-loading rifle, cast-iron, tubed with steel, has been made and is ready to receive the tube; breech mechanism made but not fitted. The other, which was nearly completed at the close of the last fiscal year, has since been completed. The wire winding of the two cast-iron 10-in. breech-loading wire-wrapped guns has been completed. The 12-in. breech-loading mortar under fabrication by contract with the South Boston Iron Works has been completed and sent to the proving ground for trial. It is expected that a record for accuracy of fire and endurance will be obtained from this piece early in the coming winter, so that a decision can be reached as to the relative merits of breech-loading and muzzle-loading mortars.

The forgings for the 10-in. breech-loading steel rifle have all been accepted. The first tube and jacket delivered by Sir Joseph Whitworth & Co., the manufacturers, were rejected after test, as they fell below the prescribed physical qualities, and were returned to England. The second set of forgings was delivered during the past year and tested with better results. The breech mechanism forgings for this gun have been accepted and delivered.

In the manufacture of these 8-in. rifle forgings, a satisfactory jacket was only obtained after repeated failures and repeated retreatment of the metal, owing to the inadequacy of the present plant at the Midvale Steel Works for such large work. But the manufacturers, it would seem, triumphed at last over their limitations—a thorough knowledge of their art enabling them to attain a success in spite of inadequate facilities. Another very encouraging sign, in the development of our steel industry, is to be observed in the early success of the Cambria Iron Works in meeting the high standard of excellence required under the specifications.

In view of the success thus far attained by our steel makers, it is apparent that all that is now required to make it feasible to produce the largest gun forgings of suitable quality in the country is the assurance that the outlay for necessary plant will prove remunerative.

The 5-in. breech-loading siege gun and its carrriage, and the 7-in. breech-loading howitzer, which were under fabrication at the Watertown Arsenal, have been completed and sent to the proving ground. The powders and projectiles required for their trials are now being procured, so that both of these guns should be heard from at an early day.

The forgings for the breech mechanism of the 10-in. gun have been delivered.

The forgings for the 8-in. breech-loading rifle have been completed and delivered. The tube and jacket forging for this gun is the largest yet made, or attempted in this country.

General Benét presents an argument in behalf of heavy guns of position, adding that "as a projectile force gunpowder yet stands supreme." Referring to the success of the "dynamite torpedo gun," as he calls it, General Benét shows its advantage over the fixed mine, but adds: "It is not intended, by implication even, that fixed mines are to be abandoned, but on the contrary, the two systems supplement each other into a vastly more powerful combination of explosives, and become a most essential adjunct to the heavy guns of great range and power, which are, of necessity, as armor-piercing weapons, the basis of all armament for coast defense. I would recommend the purchase of one of these guns, say of 12-in. caliber, for exhaustive trials of gun and projectile, with the object of determining the full extent of their capacity and fitness for coast defense."

Experiments with the Stevens dynamite shell have shown sufficient promise to justify a more extended trial, and the firings will be continued at an early day. Types of the best pneumatic gun carriages known here or elsewhere should be provided, as aids to the study and development of this vital necessity. A trial of the improved Powlett carriage should be authorized by an appropriation.

The question of a reduced caliber for small arms is now under consideration by the Department. General Benét says: "An effective and simple magazine gun has become a necessity, but from the little that can be learned of the magazine systems said to have been adopted abroad, I am persuaded that nothing is to be gained by haste at this juncture, but that the Springfield arm will continue to admirably serve our purpose and the best interest of the Army, long enough to enable us to determine finally on a magazine gun that will do credit to the inventive genius of our people."

There were 41,106 rifles and carbines manufactured at Springfield during the year. The favorable view of the Morse movable-base cartridge has been fully confirmed by the reports thus far received from five of the companies to which it was issued for trial. A large appropriation for cartridges and target material is recommended, the resources of the Department in meeting in a liberal spirit the demands for target practice being overtaxed.

LOCOMOTIVE-BOILER EXPLOSIONS ON BRITISH RAILROADS.

(*Continued from page 510.*)

WE continue below the summary of the reports made by the Inspectors to the British Board of Trade on the locomotive-boiler explosions occurring on the railroads of that country.

INSPECTORS' REPORTS.

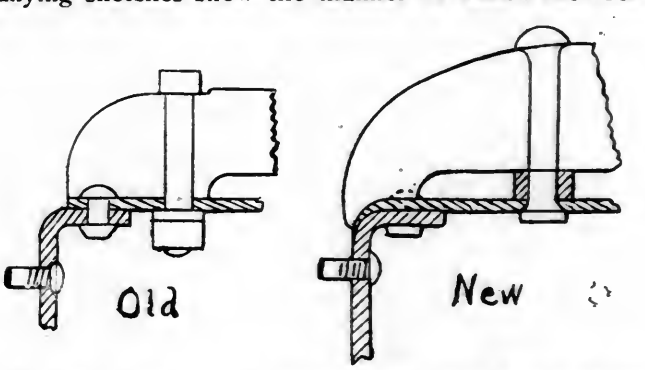
January 29, 1858, the boiler of a locomotive on the Llanelly Railway exploded near Pantyffnwn. The engine was hauling a ballast train at the time, but had just stopped for a switch to be opened. The fireman was hurt, and three boys who stood by the track were killed. The force of the explosion was mainly upward, and the boiler was torn to pieces, the shell being found in four pieces. The tubes were torn out and thrown on the tender. The engine had six wheels coupled, with 14½ × 16 in. cylinders, and was built in 1841. The boiler was of old pattern and was a cylinder of iron 51 in. diameter and 12 ft. long, the plates $\frac{7}{16}$ in. thick. It had an internal tube of ½-in. iron, 24 in. diameter and 8½ ft. long, which tube carried the grate at one end and had a combustion chamber, also of ½-in. iron, attached to it at the other. The smoke-box and chimney were at the same end as the fire-box, and 68 iron tubes, 2 in. diameter, led from the combustion chamber to the smoke-box. The boiler was repaired in 1851 and again in 1857, when several new plates were put in, and 18 new stays were added, several of the tubes being taken out. The Inspector found that the old plates in the shell were worn down in places from $\frac{7}{16}$ to $\frac{5}{16}$ and ¼ in., and believes that these worn plates were too weak to carry the ordinary pressure.

February 8, 1858, the boiler of an engine on the Brighton Railway exploded while standing at Catterham Junction. The copper fire-box gave way just below the fire-door, and the fireman was killed by escaping steam. The back sheet which gave way was found to have been reduced from ⅞ in. to ¼ in., probably by friction from the coke in firing. The engine was nine years old and had run about 200,000 miles. The explosion was probably due to the weakening of the back sheet.

June 11, 1858, the boiler of an engine on the Lancashire & Yorkshire line exploded just after the train had stopped at Lowmoor. The engine was a four-wheel coupled goods engine, with 15 × 24-in. cylinders and 5-ft. drivers; the boiler was 11½ ft. long and 45 in. diameter of barrel, with 121 brass 2-in. tubes. The iron plates were $\frac{7}{16}$ in. thick. It was built in 1846 and had new tubes in 1855 and again in 1858. The usual pressure was 75 lbs., and the safety-valve could not be changed by the engineer. The central plate of the barrel was entirely torn off and was thrown 210 ft. away; the rest of the boiler was not much injured. The fireman and a trackman, who stood near, were killed. The boiler had been patched, but not on the plate which gave way. That plate was very badly corroded, the iron being eaten out in round holes, some of 1 in. diameter; at several points these holes ran together, reducing the thickness of the plate to $\frac{3}{8}$ in. and even less. This corrosion was probably the cause of the failure.

July 24, 1858, the boiler of a locomotive on the North British line exploded at Bournmouth, where the train had just stopped. The engine was a goods engine with 18 × 24-in. cylinders and six-coupled wheels 57 in. diameter. The boiler barrel was 46 in. diameter and 10 ft. long. The fire-box was of $\frac{7}{16}$-in. copper, with 8 roof-stays or crown-bars. Two of these roof-stays gave way, and the fire-box collapsed, the crown-sheet and side-sheets being forced down and the rivets stripped off. The ordinary working pressure was 100 lbs., but from the evidence in the case, the Inspector believes that the area of the safety-valve was insufficient, and the pressure had run up to 145 lbs. and probably more.

August 16, 1859, the engine of a psssenger train on the Southeastern line exploded its boiler just as the train stopped at Lewisham. The engine was 10 years old; it had 15 × 22-in. cylinders, four-coupled wheels 66 in. diameter and leading wheels 42 in. diameter. The usual working pressure was 90 lbs. The fire-box was 42 in. long, 36 in. wide and 54 in. deep. The copper plates, originally ½ and $\frac{7}{16}$ in., had been reduced to $\frac{5}{16}$ and in some places to ¼ in. The effect of the explosion was to lay the crown-sheet of the fire-box, with all the roof-stays close down on the tube-sheet, tearing away the side-sheets about 12 in. from the top, and blowing out the grate and ash-pan. The crown-sheet was separated from the tube-sheet for about 27 in. The Inspector says: "The crown of the fire-box was stayed by 8 roof-stays 41 in. long, placed 4¼ in. apart and secured by ¾-in. rivets 1⅞ in. apart; but it will be noticed that the length of these roof-stays is less than the width of the fire-box, so that their ends do not rest on the walls of the fire-box; and in some places it is evident that the caulking has diminished the thickness of the plates. * * * * The fracture took place in the front plate close to the edge of the top plate and in a straight line coinciding with the line of the caulking, and on examination a crack in the copper, 30 in. long, was found. The marks of the ends of one or two of the roof-stays which projected furthest toward the front plate were apparent on the edge of the fracture, so that if the ends of the roof-stays had been brought further forward and had rested on the upright front plate, instead of ending on the curved and weakest part, it is probable that the explosion would not have occurred, notwithstanding the crack. There is no doubt that the explosion commenced at the front of the top of the fire-box, and at about the ordinary working pressure. * * * * The accompanying sketches show the manner in which the roof-



stays were put on this fire-box, and also (in the figure marked 'New') the manner in which they are now put on by the Southeastern Company, and the mode adopted to avoid caulking."

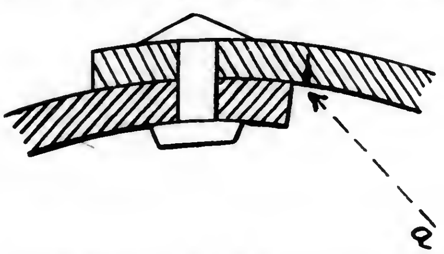
October 17, 1859, the boiler of the locomotive of a freight train on the South Yorkshire road exploded near Wombwell, just as the engineman had shut off steam. The engine had 16 × 24-in. cylinders and six wheels, 54 in. diameter, all coupled. The boiler barrel (of iron) was 48 in. diameter and 10 ft. 4 in. long; the copper fire-box was 4 ft. 6 in. long. There were two safety-valves. The engine had a light train and was blowing off steam just before. The fire-box was nearly uninjured in the explosion; the barrel was torn in two pieces, one being thrown into the ditch beside the track, the other nearly 400 ft. away. The steam dome was torn off and also thrown about 400 ft. away. The boiler plates were found to be badly corroded, in some places eaten more than half through. The explosion is believed to have resulted from weakness of the boiler, due chiefly to corrosion.

March 13, 1860, the boiler of a freight engine on the South Devon road exploded while the engine was doing some shifting at Totnes. The engine had 17 × 24-in. cylinders, with six 57-in. wheels, all coupled; it was five years old and had been repaired about a year before. The explosion tore off the outer fire-box shell, the force acting upward and to the left, and pieces of the shell were thrown through the freight shed and some distance away. This outer shell was of $\frac{7}{16}$-in. iron. The fire-box itself was of copper and stayed to the outer shell by copper stay-bolts, a number of which were torn out and carried away with the pieces of the outer shell. There were no signs

of low water or overheating. The plates, when examined after the explosion, were found to be badly corroded, in some places eaten away so that not more than $\frac{3}{16}$ in. thickness of metal was left. The explosion was attributed mainlv to this corrosion, although the Inspector thought that the boiler was not strongly braced.

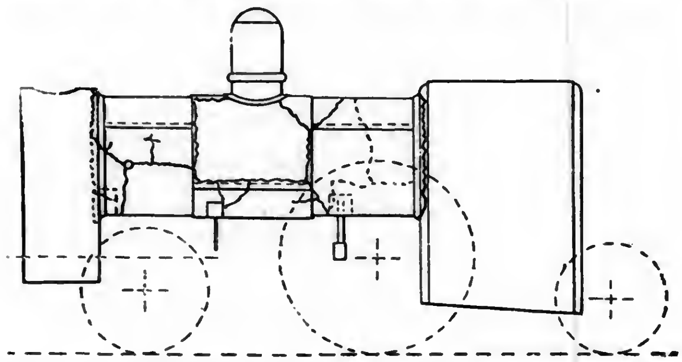
November 1, 1860, the boiler of a locomotive on the Metropolitan line exploded at the King's Cross Station. The engine was an old one; the fire-box crown-sheet gave way, and the engine was lifted up and thrown over on its side by the shock. The crown-sheet was torn away from the back and side-sheets, but remained attached to the tube-sheet. It was of copper, about 9 years old, and had been patched. In this case, as in one referred to above, the roof-stays were defective in form and really had no bearing on the side-sheets; and it was this weakness, combined with wear of the sheet, which caused the explosion.

April 1, 1861, the boiler of a locomotive on the Monmouthshire road exploded at Newport, just after the engine had stopped with a goods train. The engine was 6½ years old; it had 18 × 24-in. cylinders and six 60-in. wheels, all coupled. The boiler was of ⅜-in. iron, 51 in. diameter of barrel and 12 ft. 1 in. long. The seams in the barrel were single-riveted, the rivet-holes being countersunk about ⅛ in., reducing considerably the sectional area of the plate. The boiler had been overhauled and repaired about a year before. The effect of the explosion was to tear the leading end of the barrel away from the smoke box and to separate two of the rings (and part of the third) from the remaining ring of the barrel, which was not detached from the fire-box. The engine remained on the rails, but the leading axle was bent and the leading wheels thrown off. The Inspector believed from his examination that the explosion took place at the ordinary working pressure, about 120 lbs.; there were no signs of overheating anywhere. No part of the boiler plates, apparently, had been reduced below $\frac{5}{16}$ in. by corrosion or wear. Careful examination of the remaining plates, however, discovered at several points cracks in the plates, near the horizontal line of rivets, of the character indicated at *a* in the accompanying sketch. The Inspector



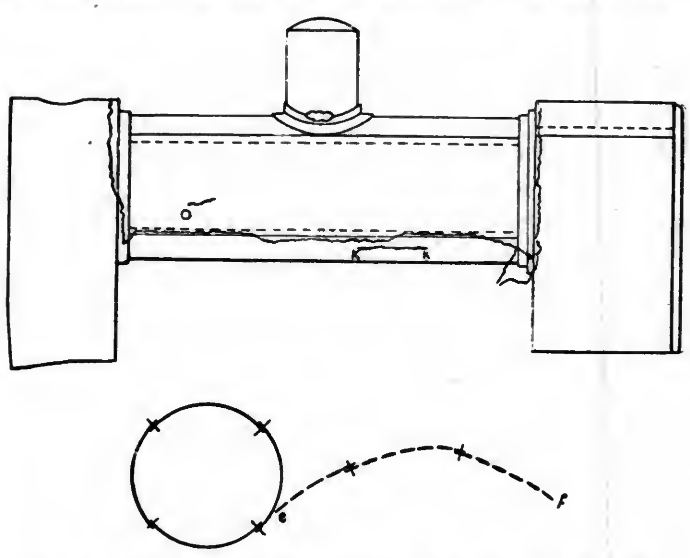
thinks that the rupture started in one of these cracks, which had so weakened the iron that it was unable longer to resist the pressure. He says: "These cracks are frequently found in old boilers, and are usually supposed to originate in the mark or indentation made by the caulking tool when incautiously held by the workman. It is quite possible that such marks may have had something to do with the origin of these cracks; but they probably result mainly from the greater rigidity of the plates at this part when opposed to the greater flexibility of the adjacent part of the boiler plates.'

July 4, 1861, the boiler of the engine of an express train on the London & Northwestern road exploded when the train was near Rugby and running at the rate of 35 miles an hour. The explosion took place just as the train was passing under an arched bridge; the barrel of the boiler was torn to pieces, leaving the fire-box almost intact. Several large pieces struck the brickwork of the bridge and left deep marks in it; one piece (about 8 × 4 ft.) was found on the back of the tender. The driving-axle was broken and one driving-wheel thrown off; the frames were bent out of shape. The middle ring of the barrel was entirely separated from the other rings and was itself left in several pieces. The accompanying drawing is a sketch of the boiler, and the irregular lines show the lines of fracture, indicating how completely it went to pieces. The force of the explosion and the reaction from the side of the arch threw the engine over on its side on the opposite track, but it ran or slid forward far enough to permit the cars in the train to stop without receiving serious damage. The fireman was fatally hurt, but the engineer was not very badly injured. The engine, which was about 10 years old, had 16 × 24-in. cylinders, one pair of 7-ft. drivers, leading and trailing wheels. The boiler was 49 in. diameter of barrel and 11 ft. 9 in. long; it was of iron, the barrel plates ⅜ in. and the outer fire-box plates $\frac{7}{16}$ in. Examination of the fractured plates showed that they



were much corroded, the line of greatest weakness being just above the lower seam on the middle ring of the barrel, where the metal had been reduced in places to little over $\frac{1}{16}$ in. in thickness. The Inspector believes that the failure of the boiler was due to this corrosion, as there was no evidence of unusual pressure, and says further that the process of weakening must have been going on for some time, and that proper inspection and removal of scale would have revealed this fact. It is to be noted that this was the very unusual case of a boiler exploding while the engine was running.

September 23, 1861, the boiler of a locomotive drawing a coal train on the Northeastern Railway exploded just as the train was ready to start from Stella Gill. The driver and fireman were badly hurt, and the guard, who was on the engine, was killed. The engine was 8 years old; it had 14½ × 22-in. cylinders and six 54-in. wheels, all coupled. The boiler barrel was 42 in. diameter and 10 ft. long. It was of ⅜-in. iron, of four plates placed longitudinally, so that there were four seams running the length of the barrel, but no circumferential seams except at the ends, where it was joined to the smoke-box and the fire-box. The usual working pressure was 80 lbs., and it does not appear that this had been exceeded. The accompanying sketch shows the general form of the boiler, the



irregular lines showing the lines of fracture. The lower sketch is a section of the barrel, the dotted lines *e f* showing the position in which the plates were found after the explosion.

The Inspector says: "An examination of the remains of the barrel leaves no doubt of the cause of the explosion. Corrosive action had been going on actively for a space of about 21 in. along the plate which gave way at

about 66 in. from the smoke-box end; and the plate had been so far eaten through that in places only ⅛ in., in others $\frac{1}{16}$ in. and at one or two points even less than $\frac{1}{16}$ in. of metal remained. The plate had thus become so thin that the force of the steam was too great for it to resist; and when once the steam and water found an opening through it, the remainder was torn and the sounder portions of the plate gave way, as always happens under such circumstances, with comparatively little difficulty." In the accompanying sketch *K K* shows the line of greatest corrosion referred to above. The Inspector makes this accident the occasion for urging more frequent inspection of boilers, more care in designing and staying them, and more care in selecting the material. He suggests that the insertion riveting in of rings of angle-iron or T-iron in the barrels would contribute very much to their strength; and also that plates might be made with thickened ends, so as to secure greater strength at the seams.

(TO BE CONTINUED.)

Electrical Subways in New York.

(From the *Electrician and Electrical Engineer.*)

IT is sometimes more important to get a thing done at once than to get it done in the most perfect way. The burying of all the electric wires in New York is not such a thing. The desirability, even the necessity, of providing some better system than the existing pole lines is very generally admitted. The objections to pole lines in the streets are so many, and have been so often recited in the public press, that everybody is familiar with them. Yet all of them put together do not constitute a public inconvenience so pressing as to justify hasty work on immature plans, such as that undertaken by direction of the Board of Electrical Control.

Since the public agitation for the removal of the pole lines, followed by the establishment of the Subway Commission, we have several times expressed our opinion that the significance and scope of the proposal to put all the electric wires in the city underground was very imperfectly apprehended by the public and by the authorities undertaking to effect it. The success of electric motors during the past two years, establishing the certainty that they will be largely employed for power throughout the city, and the development during the same period of successful means for a wide distribution of the incandescent electric light from central stations, have very largely added to the magnitude and difficulty of the problem. It has become very clear that a system of underground electric conductors will be required, sufficiently comprehensive to provide facilities far in excess of the relatively simple requirements of the telegraph and telephone service. Such system must include provision for conductors of heavy currents for the supply of power and light for general distribution throughout the city. The problem seems scarcely less in magnitude and difficulty, and in its bearing upon the welfare and beauty of the city, than that of rapid passenger traffic. The inadequacy of our means of transit is apparent to every one who travels to and fro within the city; the capacities of the elevated roads are far overtaken by the requirements of the public.

We are very confident that, if the work of providing the city with a system of underground electric conductors be left to the present methods of the Board of Electrical Control (substantially the old Subway Commission) and to their direction, our last state will be worse than our first. There is yet no evidence of the adoption of a comprehensive and thoroughly worked out plan, such as should be perfected before any extensive work is undertaken. Some elements of the problem seem to have been scarcely considered—for instance, the distribution of wires from the conduits to blocks of buildings. It cannot be said that any conduit system has been shown to be capable of meeting permanently the difficulties of a system of general distribution. Of the several conduit systems approved by the Board, some may prove serviceable for a long time, but all the work must still be considered tentative.

It is our conviction that no system of "drawing-in" conduits will avail as a permanent solution of the complex and difficult problem. It seems to us more than probable that for principal routes, where many conductors of various kinds and sizes and for many different purposes must be provided for, resort must be had to some form of tunnel, large enough to contain wires and cables hung in such a way that they shall be accessible at all points, and also large enough to permit the passage through it of linemen and small trucks for conveyance of conductors. That a way to accomplish the desired end of ridding the streets of pole lines, and to place all, or nearly all, electric conductors underground with safety and convenience, and to the satisfaction of the public, as well as of the electric companies, we make no doubt; but the undertaking should have the careful attention of electrical and engineering talent of the highest order, and should be carried out under the control of those who take a long look ahead and are more anxious to achieve a great public work carefully and thoroughly, than to satisfy an unreasonable public clamor for burying all wires at once.

Underground Conductors for Electric Lighting.

[Paper read before the British Association at Manchester by Professor George Forbes, F. R. S.]

THE author has designed the proposed system to fulfill several important conditions, as follows:

1. The conductors and their insulation should be economical in construction.
2. They should be protected from injury by a trough or casing.
3. The trough should be of small cost, and its merits must have been well tested.
4. The trough must be capable of carrying conductors at several different potentials.
5. It must be possible to add gradually to the conductors, as the consumption of electricity in a district increases.
6. An easy means must be provided for taking branches from the mains into houses.
7. An easy means must be provided for leading the conductors round gas and water pipes and other obstacles,

The first condition can best be secured by having bare copper-wire conductors and air insulation.

The second and third conditions by using ordinary cast-iron gas pipes, whose qualities are thoroughly well known, and whose laying and repairing and keeping water-tight is every-day work in every town in the country.

The fourth condition is attained by having porcelain insulating discs, two in each cast-iron pipe. Each insulator has as many holes through it as there are different potentials to be maintained. These porcelain discs are supported on the iron pipes only at a few points, the intervening spaces allowing drainage in the cast-iron pipes and also permitting dry air to be forced through a system of pipes.

The fifth and sixth conditions are attained by the special peculiarity of this invention, which consists in using thin split-copper tubes with ¼-in. gap at the split. These are each 6 in. longer than one of the iron pipes. By pinching the end of one of these tubes and inserting it into the end of another, and continuing the process, a long continuous tube can be made for carrying the bare copper-wire conductors. These continuous tubes pass through the holes in the insulators. The number of copper wires can be added to as the requirements of a district increase. When two-thirds full, these wires are all withdrawn, and a bare wire cable filling the whole space of the tubes is drawn through. The wires are drawn through from manhole to manhole. A manhole is placed at each corner of a street, and serves also as a pump for pumping out accumulations of water. When it is required to connect a house to the mains, the iron pipe is drilled and tapped with a 1-in. hole. Insulated wires are soldered to the copper tubes of the required potentials, and are led to the houses through 1-in. gas-pipes which are screwed into the holes tapped in the cast-iron pipes.

It will be noticed that the split tubes do not act primarily as the conductors of the main current, but mainly as a support for the conductors, and secondarily, by contact with these, as a means of connection to the houses, leaving the wires free to be removed or added to.

The seventh condition is to provide for getting round an obstacle. This is best done by having a hand-hole at the ends of the cast-iron pipes, on each side of the obstacle, and joining these by lead-covered insulated cables of the full current-carrying capacity of the system. These cables can be bent round the obstacle, and are in no way a weak point of the system.

The method of laying the conductors in the ordinary routine is as follows: For a three-wire system for a maximum of 2,000 lamps of ¾ ampère, a 3-in. gaspipe may be used. Each insulating disc has three 1-in. holes in the positions of the angles of an equilateral triangle. In adding fresh lengths of conductor, three split tubes are first pinched at their ends and pushed into the ends of the three split tubes projecting from the last cast-iron pipe laid. Two insulators are next run along the split tubes to a distance from either end of the tubes of one-fourth of their length. A fresh cast-iron pipe is now run along over the split tubes and their insulators, the latter fitting loosely in the pipes. The joint of the pipes is made with packing in the ordinary way. A new length is added in the same way. Manholes must be placed at each corner of a street, and may be half a mile apart. The cast-iron pipes fit into side holes in these boxes, and are fitted in with water-tight cement or packing. Wires are pulled through from manhole to manhole, and may be soldered together across the manhole. Finally, holes are drilled and tapped in the cast-iron pipes beside those houses which require a supply of electricity. Two insulated wires, bared and flattened at their ends, are soldered to those split copper tubes which are of the right potentials. A 1-in. gas pipe is screwed into the hole tapped in the main pipe, and the insulated wire is thus led into the house.

A French Light Railroad.

(From *Les Annales des Travaux Publics.*)

THE Bayonne-Anglet-Biarritz Railroad, opened June 2, 1877, deserves attention, partly because it has an exceptional traffic for a local line, and partly on account of the system of operation by light trains, adopted since its opening, the service being of the kind generally called tramway-trains.

This railroad was authorized by the Council-General of the department of Basses-Pyrenees in 1874 as a railroad of local interest, under the law of July 12, 1865, and under a schedule of charges dated September 15, 1874.

The line is 5 miles long; the profile is very irregular, 38 per cent. of its total length being in grades of .014 (74 ft. to the mile) or over, and 37 per cent. in grades of from .005 to .014 (26.4 to 74 ft. to the mile). Of the total length also, 42 per cent. is in curves of from 980 to 1,960 ft. radius.

The track is of the standard gauge, although the concession authorized a gauge of one meter. The standard gauge was adopted partly because it was expected that a connection would be made with the line Du Midi, but more especially because it was thought best to use two-storied carriages of great seating capacity. This decision as to the gauge has never been regretted by the managers.

The track is of steel rails of the Vignoles pattern, weighing 50 lbs. per yard, placed upon ties spaced 26.5 in. between centers. This track was built and is maintained with great care, and it carries without trouble locomotives having a weight of 8.5 to 9 tons per axle (4.25 to 5 tons per wheel).

The rolling-stock is composed entirely of two-story carriages, and the absence of overhead bridges permits the use of these carriages of a height of 16 or 17 ft. above the rail. These carriages are of two types; the first, which can be used alone to form a train (which is often necessary in winter), has below a first-class and a second-class compartment and a baggage-room, and above one large compartment, either open or closed according to the season, to which access is had by an interior stairway; these carriages will hold 67 passengers. The other class of carriages have one compartment above and one below; they seat 92 persons. Four carriages of this kind form a train which will carry 368 passengers, or indeed many more on busy days, for people do not object to stand for a trip of less than 15 minutes. There is no freight traffic.

The motive power consists of 5 tank locomotives, of which three weigh 19 tons each in service and have four wheels coupled; the other two weigh 25 tons each and have six wheels coupled. All these engines are on the compound system, and they are the first to which this system was applied in practice. The average consumption of fuel in six years of working did not exceed 14.5 lbs. per engine-mile.

In 1885, this Bayonne-Anglet-Biarritz road carried 724,000 passengers, of whom only 35,000 were first-class; these passengers were carried in 15,956 trains. The average train-load was 49 passengers; the average seating capacity of trains was 177, so that on an average only 27.6 per cent. of the seating capacity was occupied.

The gross receipts for the same year were 74.7 cents per train-mile; the expenses were 48.25 per cent. of the gross earnings. The cost of motive power was 14.1 cents per train-mile, for an average train of three cars, fuel alone costing 3.2 cents.

This cost of motive power was almost exactly the same as on the so-called tramway-trains on the Northern Railroad, which are about of equal capacity with one carriage of the Bayonne-Biarritz road.

Smokeless Powder.

(From the London *Times.*)

MANY military writers have expressed an earnest desire that smokeless powder, capable of being used in war, should be adopted. The advantages of such a powder are obvious. Smoke is not only a great enemy in casemates, but even in the open, especially if the atmosphere be thick and heavy; the cloud of smoke resulting from the employment of the powder now in use serves equally to hide sudden attacks by the enemy and to prevent the soldier seeing at whom he is firing and the effect of his shot. A cloud of smoke also betrays the position of troops. On the other hand, smoke defines for the benefit of a general the line of his own or the enemy's troops. Indeed, if proceeding from certain important tactical points, it adds a moral to the material effect produced by the projectiles themselves. It announces the arrival of succor, and marks the progress of the different forces executing a combined operation. Finally, it aids the assailant by enabling him, especially in the last phase of an attack, to gain ground unseen, and to be under cover from view is the next best thing to being under cover from fire. On the whole, however, a diminution of smoke is looked on as an advantage. The Schulze and the E. C. powders have this merit, but, on the other hand, their propelling power is said to be uncertain. At all events, neither of them seem to have found favor with the authorities.

A third description of so-called smokeless powder has been more fortunate as regards the good opinion of the War Office. This powder is named the Johnson-Barland powder, or for short, the J.-B. powder. Last December there was an official trial of this powder at Enfield, and a favorable report was made to the War Office. Both the Martini-Henri and the Martini-Enfield were tried on that occasion with the following results: The Government powder, 85 grains, gave with the Martini-Henri a muzzle velocity of 1,314 ft. per second, with the J.-B. powder, 60 grains, one of 1,520 ft. per second. With the Martini-Enfield the Government powder gave a muzzle velocity of 1,570 ft. per second, with the J.-B. powder one of 1,800 ft. per second.

Trials were recently made with an improved Gardner rifle-caliber machine gun; these showed that the new powder works with very little sound and very much less fouling than the ordinary powder, supporting the claims made to that extent.

The Yanegase-Yama Tunnel in Japan.

[Abstract of paper read before the British Institution of Civil Engineers, by Kinske Hasegawa, Associate Member.]

THE Tsuruga-Nagahama Railroad is a branch line, connecting the north coast of Japan with the main trunk railroad at Nagahama; it is about 27 miles long, and extends for the greater portion of its length through a flat, well-cultivated country, with favorable curves and gradients. At Yanegase, however, about 9 miles from the coast of Tsuruga, it enters a mountainous and difficult region; here a range of mountains, running from the coast of Yechizan on the north to Lake Biwa on the south, has to be crossed, and here the tunnel about to be described has been constructed. After passing through this tunnel, the line descends through a narrow gorge between the spurs of the mountains, with heavy earthworks and short tunnels, for 3 miles; it then emerges into a fertile plain, and finally terminates with a breakwater in the deep and sheltered harbor of Tsuruga.

The Yanegase-Yama tunnel commences at the summit level of the railroad, 751 ft. above sea-level and 788 ft. below the crest of the hill through which it is pierced; it runs in a direction east and west and is 4,436 ft. long; it is straight for the greater part of its length and on a curve of 990 ft. radius for a short distance at its western end; the grade throughout is 1 in 40. The work was begun in June, 1880, at the west end, and in May, 1883, at the east end; from the latter date the headings were carried forward from both ends simultaneously. The tunnel was completed March 30, 1884.

The finished section of the tunnel is 14 ft. wide at springing, with semicircular brick arch of 7 ft. radius; it is 15 ft. 6 in. high, with curved masonry side walls, 10 ft. wide at formation level, and has a central drain 1 ft. 6 in. wide and 2 ft. deep, the total sectional area being 185.58 square ft.

Trial lines were first run in February, 1880, and the line was finally decided on and ranged out in the following April, the instruments used being an ordinary 6-in. theodolite and dumpy-level. The line was ranged over the summit of the mountain, and the levels were carried round by a narrow mountain track skirting its edge at a distance of about 1½ miles in a southeastern direction, and finally the mountain itself was leveled over. The line was ranged out from fixed points. Masonry platforms, 4 ft. square, were built at these points, with centers marked thereon; the distances were carefully measured, both with steel chains and measuring rods, and were finally checked by a system of triangulation. During construction, the center-line was carefully checked through the workings twice a month, ranging being always commenced from the fixed points at the entrances, and the levels checked, permanent bench-marks being made in the side walls as the work proceeded.

The strata pierced through were much broken up and distorted, and were generally inclined at an angle of about 45° and dipping with the same inclination. Some portions of the rock were exceedingly hard, others were decomposed and intermixed with numerous thin clay veins containing much water.

The total length of 4,436 ft. may be subdivided as follows:

	Feet.
Wet clay and gravel	782
Moderately hard rock and thin clay veins	350
Very hard rock	230
" " " with thin clay veins	54
Decomposed rock	3,020
Total	4,436

Some portions of the ground were very wet. Excavation was carried out in the usual manner. The working hours were three shifts of eight hours, but in very wet places the shifts were increased to four of six hours. Powder was the explosive first used; in September, 1880, dynamite was introduced. Explosives were never allowed to be taken into the workings, except in small quantities as required, and then only by men expressly appointed to take charge of them; and they were only given out on the order of the foreman in charge. The timbering was composed of green Matsu (pine), the poling boards being 1½ in. thick by 9 to 12 in. broad. Some trouble was experienced from the timbers being attacked by insects, but carbolic acid injected into the holes made by them completely checked their ravages. The tunnel, as before remarked, is on a sharp curve at the west end, and for the purpose of securing accuracy in the long straight portion the west entrance was taken out at a tangent to the curve. The size of the headings varied from 7 ft. by 7 ft. to 8 ft. by 9 ft., depending a good deal on the nature of the stuff worked through. In driving the heading through rock, generally three or four holes were drilled, 2 or 3 ft. deep, and ⅓ to ¾ lb. of dynamite was placed in each; this usually loosened the rock to the full depth of the holes, but in some places the rock was so hard that the dynamite so distributed had no effect, and a larger number of holes had to be drilled; even then only 6 to 9 in. could be got out in 24 hours, and as many as 30 or 40 drills were worn out in the process of drilling them. In driving the heading through soft, wet strata, it was usual to raise the roof from 2 to 3 ft., as it got pressed down during the operation of changing the timber supports.

When much water was met with, it brought out large quantities of gravel and clay with it, hollowing out the roof. This was prevented by close poling covered with mats or straw, which permitted the water to pass through but held back the gravel and clay.

Moderately hard rock was excavated by pick or chisel, blasting being only occasionally resorted to. In one length of about 185 ft. where thin veins of clay were interspersed, the volume of water was so great as to fill up a length of 11 ft. of the heading with the rubbish brought in with it, causing a delay of three days; and at various other points in the hard rock, owing to the inrush of water, much difficulty was experienced in drilling and charging the holes for blasting. Two lines of railroad of 2-ft. gauge were laid down for removing and for bringing in materials.

When the heading had been driven about 300 ft., the ventilation became very bad; to improve it and create a current of air, advantage was taken of a stream of water coming down the hill. Two conical timber troughs were provided; one of them, with the larger end uppermost, was placed under the fall, and a trough from near the smaller end led into the workings, up which the falling water forced a current of fresh air; the second, with the smaller end uppermost under the fall, drew out the foul air through another tube. However, constant trouble and interruption occurred through the timber tubes being knocked about and leaking; tin tubes were then substituted, and this arrangement answered pretty well until a distance of about 1,440 ft. from the entrance was reached, when ventilation again became very deficient, causing frequent stoppages. A blower 3 ft. in diameter was then adopted, driven by a water-wheel 12 ft. in diameter and connected with the advanced works by cast-iron and tin pipes. This answered tolerably well for a time, but after about 5 months the air became bad again. The next appliance used was an air-compressor and turbine; from the time this was put to work there was not much trouble with the ventilation.

Ingersoll rock-drills were used to a limited extent; they were found very satisfactory in hard, compact rock, but this was rare in the tunnel, the rock being generally broken up or interspersed with thin clay veins, and the powerful percussion of these drills so shook the rock that holes could not be drilled by them.

The total cost of the tunnel was 449,457 yen, that is, about $368,000, being about $83 per lineal foot.

The principal materials used in the construction were:

Bricks, number	2,704,640
Cement (Portland, Fukugawa and Selenitic)	705 tons
Lime	2,522 cub. ft.
Sand	90,288 cub. ft.
Stone	103,000 cub. ft.

The original paper is illustrated with numerous sketches showing the progress of the work and other interesting features.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

CHAPTER V.
THE EXPANSIVE ACTION OF STEAM.

QUESTION 80. *How is the expansive action of steam referred to in the answer to question 40 utilized in steam engines?*

Answer. The valve and its movement are so arranged that the steam-ports, through which steam is admitted to the cylinder, are each open during a portion only of the stroke of the piston. When it has moved through a part of its stroke, the port through which steam is entering the cylinder is closed, without allowing the steam which has been admitted to the cylinder to escape, until the piston has nearly reached the end of its stroke. Consequently when the steam is thus enclosed, or "cut-off" as it is termed, its expansive action continues to exert a diminishing pressure against the piston until the exhaust port is opened. Thus, in fig. 20, it will be seen that the valve has nearly closed the steam-port, although the piston has not yet reached the end of its stroke. Fig. 34 shows the valve on an enlarged scale in the position it occupies when the steam-port *c* is first closed; and in fig. 35 the valve is represented after it has moved far enough to begin to open communication from the steam-port *c* to the exhaust-port *g* as indicated by

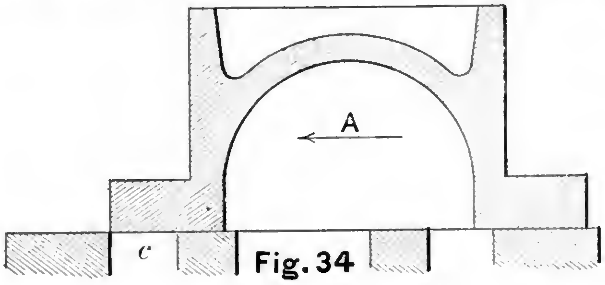


Fig. 34

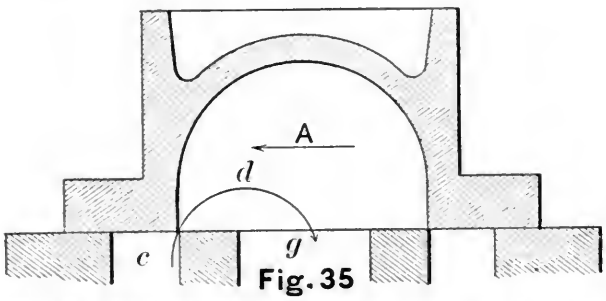


Fig. 35

the dart *d*. While the valve is moving from the position in which it is shown in fig. 34 to that represented in fig. 35, it is evident that the steam-port *c* is covered by the valve, and therefore during that period the steam is confined in the front end of the cylinder and expands as the piston advances. It thus exerts a pressure on the piston after the steam-port is closed. As the piston advances, and the space or volume occupied by the steam in the cylinder is increased, the pressure of the steam is reduced as was explained in answer to question 42.

QUESTION 81. *How can we know how much pressure is exerted by the steam during expansion?*

Answer. As long ago as the year 1662 Robert Boyle, from experiments "touching the spring of air," discovered the law that "*the pressure of a portion of gas at a constant temperature varies inversely as the space it occupies;*" or, as stated in answer to question 42, *they are inversely proportional to each other.* Thus, suppose we have a long cylinder, *A*, fig. 36, with a piston, *a*, and that the space below the piston is filled with air of 15 lbs. absolute pressure per square inch—if we press the piston down so that the space below it will be only one-half that below *a*, as shown in cylinder *B*, then the pressure of the air will be 30 lbs. per square inch or *double* what it was in *A*. Or if the space below the piston *e* in the cylinder *E* is filled with air of 100 lbs. absolute pressure per square inch, and we allow the piston to rise, as shown in cylinder *C*, so that the space below it will be double what it is in *E*, then the pressure of the air will be 50 lbs. per square inch or *one-half* what it was in *E*. The same principle is illustrated by the cylinders *I* and *E*. The space below the piston *i* is full of air of 200 lbs. pressure, and if it is allowed to expand to double the volume, as shown in *E*, the pressure will be halved; or conversely if the piston *i* is pressed down so that the space below it has only half the original volume, as shown in *I*, then the pressure of the air will be doubled.

QUESTION 82. *How may the action of this law be illustrated for any range of pressure?*

Answer. It may be represented graphically if we will first draw a line, *J K*, fig. 36, and divide it into equal divisions, to any convenient scale, to represent absolute pressure per square inch of steam as indicated by the figures above the line. Next a vertical line, 15 *a*, should be drawn from the division representing 15 lbs. pressure, and this line should be made the axis or center line of the cylinder *A*. Then let the space below the piston *a* represent to any convenient scale the volume occupied by any given quantity of air of 15 lbs. pressure. If, now, other cylinders *B, C, D, E, F, G, H* and *I* be drawn with vertical lines erected from the divisions indicating 30, 50, 75, 100, 125, 150, 175 and 200 pressure for their axes, and the spaces below their pistons be made to represent the volumes of air of 30, 50, 75, etc., lbs. pressure per square inch, the positions of these pistons above the line *J K* will represent to the eye the relative volume of the air of the different pressures. Further, if we draw a curved line, *a b c d e f g h i*, through the pistons, its vertical distance above the line *J K* at any given point will represent the *volume* of air of the pressure indicated by that point. Thus, the length of the dotted line 40 *m* represents the relative volume of air at 40 lbs. pressure, compared with that of 15 lbs. shown by the line 15 *a*.

QUESTION 83. *How may the pressure of air of different volumes be represented?*

Answer. If a vertical line, *a p*, fig. 37, be drawn equal to *a* 15 of fig. 36, and the vertical positions of the pistons *a, b, c*, etc., in the cylinders *A, B, C*, etc., be represented by the horizontal lines *a a'*, *b b'*, *c c'*, etc., and we lay off to any convenient scale a distance *a a'*=15, *b b'*=30, *c c'*=50, etc., and draw a curve *a' b' c'* —*i'* through the extremities of these lines, then the horizontal dis-

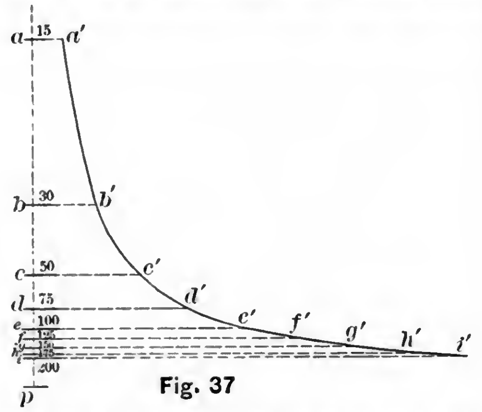


Fig. 37

tance of this curve from any point of the line *a p* will represent the pressure of air of a volume indicated by the position of the point on *a p*. It will be understood that the distance *a p* represents the volume of air at 15 lbs. pressure, and that the distance *b p* represents its volume when the piston has been pushed down from *a* to *b*. So the distance from *p* to *c d e*, etc., represents the volume of the air when the piston has been forced down to these points.

QUESTION 84. *Do all gases act in conformity with Boyle's law?*

Answer. All of what are known as fixed gases—that is, those which cannot be readily liquefied by cold or pressure—with slight variations, act in accordance with this law, but steam and some other gases, which can be condensed easily, vary somewhat from it, as was explained in answer to question 45. Some of the reasons for this variation are not yet thoroughly understood, and the explanation of those which are would require the use of mathematics, and the explanation of abstruse scientific principles which would be out of place in an elementary book like this. For the present these variations may be disregarded, as all that is aimed at is to give a general idea of the nature of the law which governs the volume and pressure of gases.

QUESTION 85. *How can the relation existing between the heat, pressure and volume of steam be shown?*

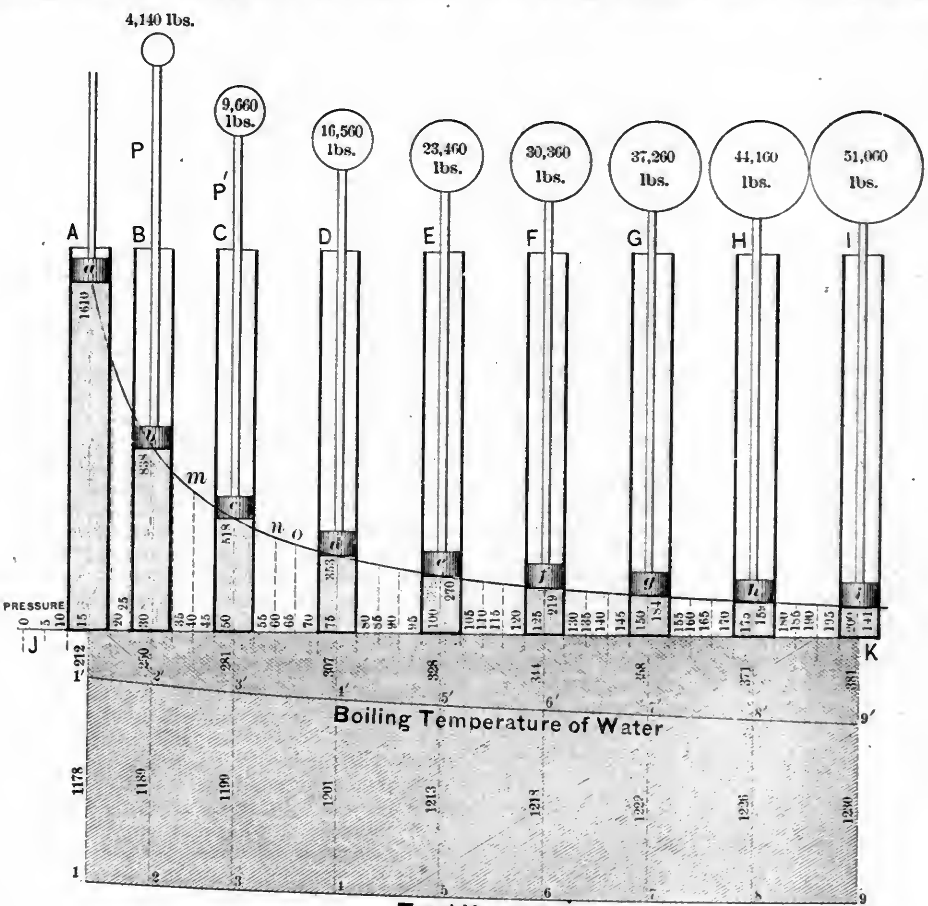
Answer. The table which is published on page 574 gives the pressure, the temperature, the total heat, the weight and the relative volume of steam compared with the water from which it was raised, and a study of this table will give an idea of the relation referred to. But as it is difficult to get a clear conception of a general law from so many figures, we will illustrate

it by the diagram, fig. 36. Let it be supposed that each of the cylinders represented there is drawn to a scale of ⅛ in.= 1 foot and that they are 18¾ in. in diameter. These pistons, therefore, have an area of 276 square inches. It will be supposed further that a pound of water which has a volume of 27.6 cubic inches is put into each cylinder. This would occupy a space in the bottom of the cylinders only one-tenth of an inch thick. On the scale to which the diagram is drawn it is impossible to represent the volume of the water. It would be less than the space between the dotted lines below the piston. From what has been said, though, an idea can be formed of the small amount of space, comparatively, which the water would occupy in the cylinders. If heat is now applied to the bottom of the cylinder *A*, so as to convert the water in it into steam, it will push the piston *a* upward against the pressure of the atmosphere; and if the piston had no weight, the steam would occupy a space 1,610 times as great as that of the water. The space below the piston, which is shaded with dotted lines, is supposed to represent the volume of the steam and is drawn to a scale so that, if the reader has a clear conception of the space which the water occupied in the cylinder,

QUESTION 86. *How is the temperature of the water and the total heat of steam shown in the diagram?*

Answer. To show this, vertical lines 15 1, 30 2, 50 3, etc., are drawn from the points on the horizontal line *J K* which represent 15, 30, 50 lbs. pressure. On these lines distances 15 1', 30 2', 50 3', etc., are laid off in a scale of $\frac{1}{10}$ in.=100 degrees, to represent the temperature at which water boils at the pressure indicated by the figures on the line *J K*. A curve, 1' 2' 3'—9', is then drawn through these points, and its vertical distance from any point in the line *J K* represents the temperature of water corresponding with the pressure of steam indicated by that point on *J K*.

It has already been explained in the answer to question 62 that after water is heated up to the boiling point that an additional amount of heat must be imported to it to convert it into steam. This, with that which is required to heat the water, is called the "total heat" of steam. In the table this heat is given in degrees. It was supposed that 1 lb. of water was put into each of the cylinders and that it was converted into steam of the pressures indicated by the figures at the lower part of the cylinders. The boiling temperature of the water



Total Heat of Steam

Fig. 36

the shaded area below *a* will show him the relative volumes of the water and the steam generated from it.

If we put a weight, *W*, on top of the rod *P*, connected to the piston *b*, equal to 15 × 276=4,140 lbs., with the pressure of the atmosphere it will produce a pressure downward equal to an upward pressure below the piston of 30 lbs. per square inch. If under these conditions the water in the cylinder was converted into steam, it will raise the piston up so that the steam will occupy a space 838 times or a little more than half as much as it would occupy with only 15 lbs. pressure. In the same way the pistons *c*, *d*, *e*, *f*, *g*, *h* and *i* are each supposed to be loaded, so that the pressure required to raise them will be 50, 75, 100, 125, 150, 175 and 200 lbs. per square inch respectively. The spaces occupied by the steam would then be 518, 353, 270, 219, 184, 159 and 141 times that of the water. The shaded areas below the pistons represent the volume of 1 lb. of steam of the pressures indicated. The curve *a b c—i* drawn through the pistons will then represent the relative volumes of steam of different pressures just as it did of air already described. The slight difference in the volumes of air and steam due to temperature and other causes may for the present be disregarded. The diagram, fig. 37, shows the pressure of steam of different volumes just as it does of air, which has been explained.

therefore represents units of heat. If we extend the vertical lines below *J K* and lay off on 15 1, 30 2, 50 3, etc., the number of degrees of total heat—to the same scale as before—required to convert the water into steam, and draw a curve through the extremities 1 2 3—9 its vertical distance below *J K* will represent the total units of heat required to convert 1 lb. of water into steam of the pressure indicated on *J K*. The area below *J K* and the curve 1 2 3—9 is shaded with lines in one direction only, while that between *J K* and 1', 2', 3'—9' is shaded with cross lines. These shaded areas convey a clear idea to the mind of the *quantity* of heat in a pound of steam of different pressures.

QUESTION 87. *What is the relative quantity of heat required to convert a given weight of water into steam of different pressures?*

Answer. The number of degrees or units of heat required to boil 1 lb. of water under the pressures indicated is given in figures on the vertical lines 15 1', 25 2', 50 3', etc., and the total units of heat required to evaporate the same quantity of water from zero is given on the lines 1' 1, 2' 2, 3' 3, etc. From these figures and also from the shape of the curve, it will be seen that it requires 169 more units of heat to make water boil under a pressure of 200 lbs. than is required with atmospheric pressure of 15 lbs. Somewhat less heat is needed, though, to convert

boiling water into steam, as the pressure increases. It will also be noticed that the total heat is very little more for the high pressures than for that of the atmosphere.

QUESTION 88. *How can we determine by experiment the pressure of the steam in the cylinder at all points of the stroke of the piston?*

Answer. By the use of an instrument made for that purpose, called an *indicator.* Its action can be best explained by supposing that we have a small cylinder, *C*, with a piston, *T*, fig. 38 (shown on an enlarged scale in fig. 39), and that the cylinder is connected by a pipe, *U*, to the front end *f* of the cylinder *A*, so that when steam is admitted to that end, it will be conducted to *C* through the pipe *U*. Over the small piston *T* and attached to it is a spiral spring, *s*, which is compressed when the piston rises and extended when it falls. To the top of the piston-rod *T*, fig. 39, a pencil, *W*, is attached. Behind this pencil we will suppose there is a card, *a b d c*, and that this card is so arranged that we can slide it horizontally and in contact with the pencil point. With only the pressure of the atmosphere above and below the piston *T*, the spring would be neither compressed nor extended, and the piston would then stand in the position shown in fig. 39. If, now, we move the card horizontally, the pencil will draw a line, *g h*, called the *atmospheric line.* We will now suppose that the tension of the spring is such that a pressure of 10 lbs. per square inch above or below the piston will either extend or compress the spring ¼ inch. In other words, every pound of pressure per square inch in the piston will move it $\frac{1}{40}$ of an inch. If we could produce a vacuum under the piston, it would be pressed down by the atmosphere above it $\frac{15}{40}$, or ⅜ of an inch. If, when it is

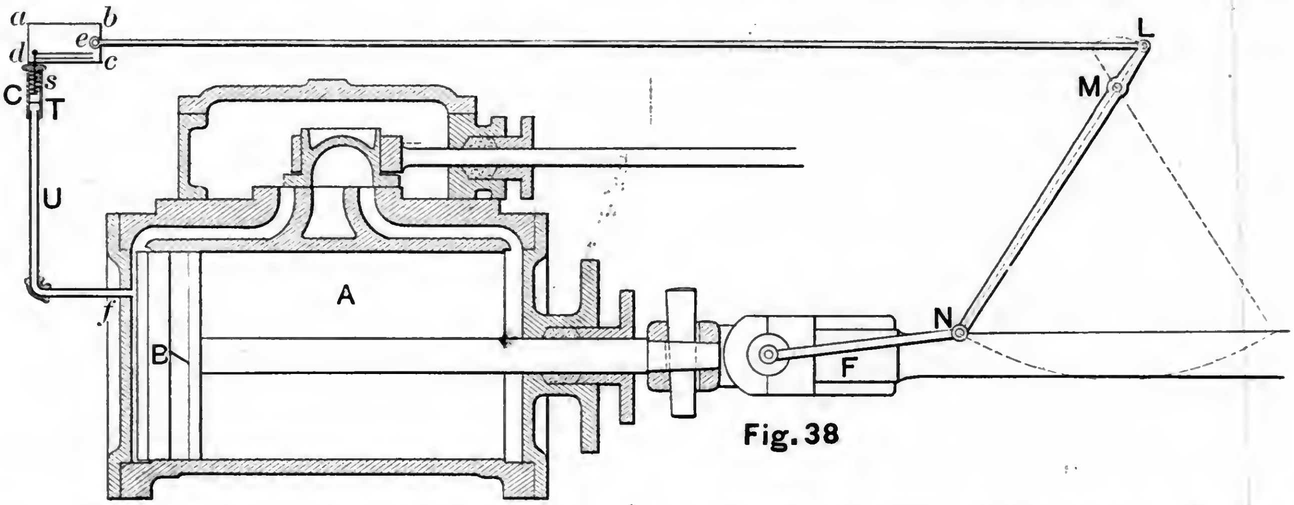


Fig. 38

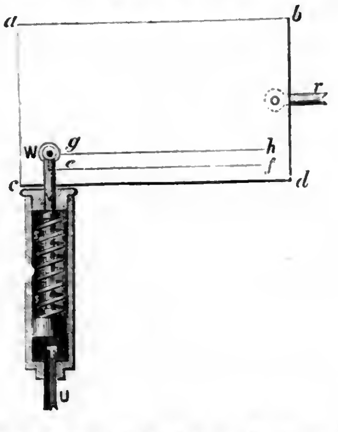


Fig. 39.

thus depressed, we again slide the card along in contact with the pencil-point, it will draw another line, *e, f*, called the *vacuum-line.* Assuming that we have drawn these two lines, and that the piston and card are in the position shown in figs. 38 and 39, we will then suppose that a reciprocating motion can be given to the card by the lever *L M N*, fig. 38, which is pivoted at *M* and attached at *N* to the cross-head by a short connecting-rod, *F*. It is obvious that by connecting the upper end *L* of the lever with a rod, *e L*, to the card *a b c d*, the latter will be moved backwards and forwards by the motion of the piston *B*, and that the motion of the card will be simultaneous with that of the piston, but of course of shorter stroke. We will assume that the stroke of the card is equal to the length of the atmospheric and vacuum lines *g h* and *e f*, fig. 39. If, now, the piston being at the beginning of the stroke as shown in fig. 38, we admit steam of 85 lbs. effective pressure per square inch (which is equal to 100 lbs. absolute pressure) into the cylinder *A*, it will be conveyed through the pipe *f U* to the cylinder *C* and will force up the piston $\frac{85}{40}$ or 2⅛ inches above the atmospheric line, or $\frac{100}{40}$ or 2½ inches above the vacuum line, as shown in fig. 40, and the pencil will draw a vertical line, *g i*, on the card (represented by a dotted line in fig. 40). We will suppose further that steam is admitted during 8 inches of the stroke and is then cut off. When the piston *B*, fig. 38, has moved that distance, which is one-third of its stroke, the card will also have moved one-third of its stroke, and will stand in relation to the pencil in the position represented in fig. 41, and as the absolute steam pressure in the cylinder was maintained at 100 lbs. while the card was moving that distance, the pencil will have drawn a horizontal line, *i j*. The steam is now cut off and begins to expand, and its pressure is thereby reduced. When the piston of the engine is at half-stroke, the card will also be at half-stroke, and the steam will be expanded from 8 to 12 inches of the stroke. By the rule given in the answer to question 39, its absolute pressure would then be 66⅔ lbs., and the indicator-piston will then be pressed down by the spring, so that the pencil will stand in the position shown in fig. 42, or 66⅔ fortieths of an inch above the atmospheric line. The pencil meanwhile will have drawn the curved line *j k*. When the piston has moved 16 inches, the steam will be expanded to double its volume, and its absolute pressure will therefore be 50 lbs., and consequently the pencil will stand 50 fortieths or 1¼ in. above the atmospheric line as shown in fig. 43, and the pencil will have continued the curve *j k* to *l*. At 20 in. the steam will have 40 lbs., and at the completion of the stroke 33⅓ lbs. absolute pressure, and the pencil will have completed the curve *j k l m n*, as shown in figs. 44 and 45. This curve is called the *expansion curve*, and its form approximates to what mathematicians call a hyperbolic curve. If the steam is exhausted, the indicator-piston will descend and carry the pencil down to the atmospheric line, and the vertical line *n h*, fig. 46, will be drawn. On the return stroke, after the steam is exhausted from the engine cylinder *A*, fig. 38, the pencil would draw the atmospheric line *g h*, fig. 46, thus showing that there is no steam pressure under the piston.

Such a diagram is called an *indicator diagram.** In practice there are a great many influences which modify it, such as condensation, performance of work, imperfection of valve gear, etc., but for the present these are disregarded.

QUESTION 89. *How can we ascertain the pressure of the steam for any point of the stroke from such a diagram?*

Answer. By measuring the vertical distance of the expansion curve (fig. 46) from the vacuum or the atmospheric line, as for example 8 *j*, 12 *k*, 16 *l*, 20 *m*. As the indicator spring is extended or compressed one-fortieth of an inch† for every pound of pressure per square inch, either above or below the indicator piston, if we construct a scale, *S S*, fig. 46, divided into divisions of one-fortieth of an inch each, one of them will represent one pound of pressure per square inch if measured vertically from the atmospheric or vacuum line. If we subdivide the vacuum line with the same number of parts as there are inches in the stroke of the piston (see fig. 47) we can draw

*The indicator used in practice, to show the action of the steam in the cylinders of steam engines, differs essentially in its construction from that which we have described. The principles of operation are, however, the same in both. We will explain the construction of an indicator hereafter.

† Indicator springs are used of various degrees of tension, in proportion to the steam pressure to be indicated.

vertical lines from these points and thus determine the pressure by comparing the length of such lines with the scale *S S*. Thus the line 8 *j* measures 100 fortieths of an inch, thus showing that the absolute steam pressure at 8 inches of the stroke was 100 lbs. per square inch ; the line 12 *k* measures 66⅔ fortieths of an inch, thus showing that at 12 in. of the stroke the steam pressure was 66⅔ lbs. At 16, 20 and 24 in. of the stroke the vertical lines measure 50, 40 and 33⅓ fortieths ; and, therefore, there were that number of pounds of steam pressure when the piston was at the point of the stroke named. Similar measurements could be made from other points, such as 2, 6, 10, or any other number of inches of the stroke. Of course, if we measure from the vacuum line we will have the

Fig. 40

Fig. 41

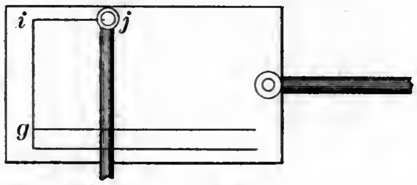


Fig. 42

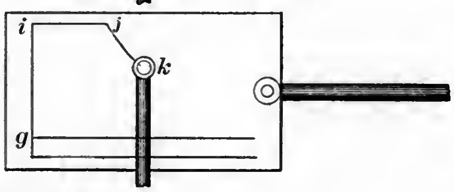
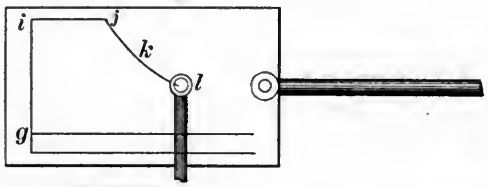


Fig. 43



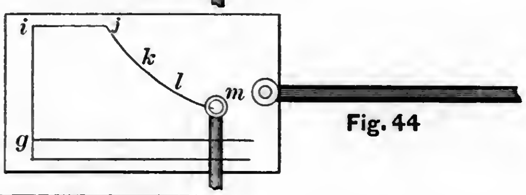


Fig. 44

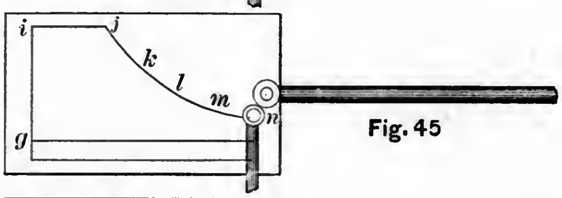


Fig. 45

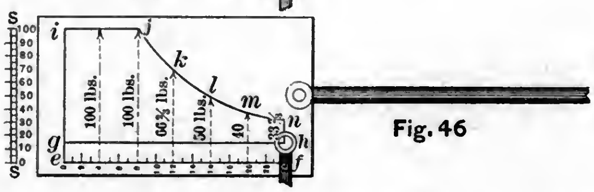


Fig. 46

absolute steam pressure, or the pressure *above a vacuum*, as it is sometimes called ; if we measure from the atmospheric line we will have the effective pressure, or the *pressure above the atmosphere*.

QUESTION 90. *How can we determine the average pressure during the whole stroke of steam which works expansively?*

Answer. This can be determined approximately by the following method : In the first place, divide the vacuum line (fig. 47) into any number of equal divisions, say six. From the points of division, 4, 8, 12, 16 and 20, which in this case correspond with the points which represent inches of the stroke, draw perpendicular lines, which will divide the indicator diagram into six divisions. It is obvious that during the time the steam is working full stroke the pressure is uniformly 100 lbs. absolute. While the piston is moving from 8 to 12 in., the pressure falls from 100 to 66⅔ lbs., so that at 10 in. we have very nearly the average pressure during the period named. So from 12 to 16, 16 to 20 and 20 to 24 the average is nearly 57.1, 44.4 and 36.3 lbs., respectively. Now, BY ADDING TOGETHER THE PRESSURES IN THE MIDDLE OF EACH ONE OF A NUMBER OF EQUAL DIVISIONS OF THE STROKE AND DIVIDING BY THE NUMBER OF DIVISIONS, WE WILL OBTAIN APPROXIMATELY THE AVERAGE ABSOLUTE PRESSURE DURING THE WHOLE STROKE. TO GET THE AVERAGE EFFECTIVE PRESSURE, DEDUCT THE ATMOSPHERIC PRESSURE FROM THE RESULT. The calculation would in the above case be as follows :

$$\begin{array}{r l}
 & 100 \text{ lbs.} \\
 & 100 \text{ ''} \\
 & 80 \text{ ''} \\
 & 57.1 \\
 & 44.4 \\
 & 36.3 \\ \hline
6) & 417.8 \\ \hline
 & 69.6 = \text{Average absolute pressure.} \\
 & 15 \\ \hline
 & 54.6 = \text{Average effective pressure.}
\end{array}$$

A more accurate way of calculating the average or mean pressure, as it is called, when steam is used expansively, and the one which is usually employed, is to DIVIDE THE LENGTH OF THE PISTON'S STROKE IN INCHES BY THE NUMBER OF INCHES AT WHICH THE STEAM IS CUT OFF : THE QUOTIENT IS THE RATIO OF EXPANSION. GET THE HYPERBOLIC LOGARITHM OF THE RATIO OF EXPANSION FROM THE TABLE OF LOGARITHMS (on another page), ADD 1 TO IT, AND DIVIDE THE SUM BY THE RATIO OF EXPANSION AND MULTIPLY THE QUOTIENT BY THE MEAN ABSOLUTE STEAM PRESSURE IN THE CYLINDER DURING ITS ADMISSION. THE RESULT WILL BE THE MEAN ABSOLUTE PRESSURE DURING THE STROKE. TO GET THE MEAN EFFECTIVE PRESSURE, DEDUCT ATMOSPHERIC PRESSURE.

The calculation for the above example would be as follows :

$$\frac{24}{8} = 3 = \text{Ratio of expansion.}$$

$$\frac{1.0986 + 1}{3} \times 100 = 69.95 = \text{Mean absolute pressure.}$$

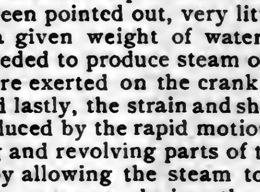
$$69.95 - 15 = 54.95 = \text{Mean effective pressure.}$$

QUESTION 91. *What advantages result from using steam expansively?*

Answer. The most important one is that considerably more work can be done with a given amount of fuel if the steam generated thereby is worked expansively than if it is not.

This is shown by the diagram, Fig. 36, in which a pound of water is supposed to be converted into steam of 15 lbs. pressure in the cylinder *A*. As already explained this takes 1,178 units of heat. By the addition of 52 units, or a little over 4

Fig. 47.



per cent. more, the water would have been converted into steam of 200 lbs. pressure as shown in the cylinder *I*. At this pressure, if allowed to act expansively, it would do a much larger amount of work than a pound of steam of 15 lbs. pressure, and, as has been pointed out, very little more heat is required to convert a given weight of water in steam of high pressure than is needed to produce steam of a low pressure.

Next, the pressure exerted on the crank is equalized by expansive action, and lastly, the strain and shocks to the mechanism which are produced by the rapid motion of the piston and other reciprocating and revolving parts of the engine are very much diminished by allowing the steam to expand, and thus become reduced in pressure during the latter part of the stroke.

QUESTION 92. *How is fuel saved by using steam expansively?*

Answer. By utilizing its capacity to expand to do work. This energy, which steam can exert by expanding, would be lost if the steam escaped from the cylinder at the pressure that it entered it. This can be illustrated by the diagram, fig. 47, in which steam is supposed to be admitted during one-fourth of the stroke of the piston at a working pressure of 85 lbs. The average effective pressure during the whole stroke, it was shown, was 54.95 lbs. This pressure acting on a piston of 16

TABLE OF HYPERBOLIC LOGARITHMS.

Num.	Logarithms.	Num.	Logarithms.	Num.	Logarithms.	Num.	Logarithms.	Num.	Logarithms.	Num.	Logarithms.	Num.	Logarithms.	Num.	Logarithms.
1.01	.0099	1.69	.5247	2.37	.8628	3.05	1.1151	3.73	1.3164	4.41	1.4838	5.09	1.6272	5.77	1.7526
1.02	.0198	1.70	.5306	2.38	.8671	3.06	1.1184	3.74	1.3190	4.42	1.4838	5.10	1.6292	5.78	1.7544
1.03	.0295	1.71	.5364	2.39	.8712	3.07	1.1216	3.75	1.3217	4.43	1.4883	5.11	1.6311	5.79	1.7561
1.04	.0392	1.72	.5423	2.40	.8754	3.08	1.1249	3.76	1.3244	4.44	1.4906	5.12	1.6331	5.80	1.7578
1.05	.0487	1.73	.5481	2.41	.8796	3.09	1.1281	3.77	1.3271	4.45	1.4929	5.13	1.6351	5.81	1.7595
1.06	.0582	1.74	.5538	2.42	.8837	3.10	1.1314	3.78	1.3297	4.46	1.4914	5.14	1.6370	5.82	1.7613
1.07	.0676	1.75	.5596	2.43	.8878	3.11	1.1346	3.79	1.3323	4.47	1.4973	5.15	1.6389	5.83	1.7630
1.08	.0769	1.76	.5653	2.44	.8919	3.12	1.1378	3.80	1.3350	4.48	1.4996	5.16	1.6409	5.84	1.7647
1.09	.0861	1.77	.5709	2.45	.8960	3.13	1.1410	3.81	1.3376	4.49	1.5018	5.17	1.6428	5.85	1.7664
1.10	.0953	1.78	.5766	2.46	.9001	3.14	1.1442	3.82	1.3402	4.50	1.5040	5.18	1 6448	5.86	1.7681
1.11	.1043	1.79	.5822	2.47	.9042	3.15	1.1474	3.83	1.3428	4.51	1.5062	5.19	1.6463	5.87	1.7698
1.12	.1133	1.80	.5877	2.48	.9082	3.16	1.1505	3.84	1.3454	4.52	1.5085	5.20	1.6486	5.88	1.7715
1.13	.1222	1.81	.5933	2.49	.9122	3.17	1.1537	3.85	1.3480	4.53	1.5107	5.21	1.6505	5.89	1.7732
1.14	.1310	1.82	.5988	2.50	.9162	3.18	1.1568	3.86	1.3506	4.54	1.5129	5.22	1.6524	5.90	1.7749
1.15	.1397	1.83	.6043	2.51	.9202	3.19	1.1600	3.87	1.3532	4.55	1.5151	5.23	1.6544	5.91	1.7766
1.16	.1484	1.84	.6097	2.52	.9242	3.20	1.1631	3.88	1.3558	4.56	1.5173	5.24	1.6563	5.92	1.7783
1.17	.1570	1.85	.6151	2.53	.9282	3.21	1.1662	3.89	1.3584	4.57	1.5195	5.25	1.6582	5.93	1.7800
1.18	.1655	1.86	.6205	2.54	.9321	3.22	1.1693	3.90	1.3609	4.58	1.5216	5.26	1.6601	5.94	1.7817
1.19	.1739	1.87	.6259	2.55	.9360	3.23	1.1724	3.91	1.3635	4.59	1.5238	5.27	1.6620	5.95	1.7833
1.20	.1823	1.88	.6312	2.56	.9400	3.24	1.1755	3.92	1.3660	4.60	1.5260	5.28	1 6639	5.96	1.7850
1.21	.1962	1.89	.6365	2.57	.9439	3.25	1.1786	3.93	1.3686	4.61	1.5282	5.29	1.6658	5.97	1.7867
1.22	.1988	1.90	.6418	2.58	.9477	3.26	1.1817	3.94	1.3711	4.62	1.5303	5.30	1.6677	5.98	1.7884
1.23	.2070	1.91	.6471	2.59	.9516	3.27	1.1847	3.95	1.3737	4.63	1.5325	5.31	1.6695	5.99	1.7900
1.24	.2151	1.92	.6523	2.60	.9555	3.28	1.1878	3.96	1.3726	4.64	1.5347	5.32	1.6714	6.00	1.7917
1.25	.2231	1.93	.6575	2.61	.9593	3.29	1.1908	3.97	1.3787	4.65	1.5368	5.33	1.6733	6.01	1.7934
1.26	.2341	1.94	.6626	2.62	.9631	3.30	1.1939	3.98	1.3812	4.66	1.5390	5.34	1.6752	6.02	1.7950
1.27	.2390	1.95	.6678	2.63	.9669	3.31	1.1969	3.99	1.3857	4.67	1.5411	5.35	1.6770	6.03	1 7967
1.28	.2468	1.96	.6729	2.64	.9707	3.32	1.1999	4.00	1.3862	4.68	1.5432	5.36	1.6789	6.04	1.7984
1.29	.2546	1.97	.6780	2.65	.9745	3.33	1.2029	4.01	1.3887	4.69	1.5454	5.37	1.6808	6.05	1.8000
1.30	.2623	1.98	.6830	2.66	.9783	3.34	1.2059	4.02	1.3912	4.70	1.5475	5.38	1.6826	6.06	1.8017
1.31	.2700	1.99	.6881	2.67	.9820	3.35	1.2089	4.03	1.3937	4.71	1.5496	5.39	1.6845	6.07	1.8033
1.32	.2776	2.00	.6931	2.68	.9858	3.36	1.2119	4.04	1.3962	4.72	1.5518	5.40	1.6863	6.08	1.8050
1.33	.2851	2.01	.6981	2.69	.9895	3.37	1.2149	4.05	1.3987	4.73	1.5539	5.41	1.6882	6.09	1.8066
1.34	.2926	2.02	.7030	2.70	.9932	3.38	1.2178	4.06	1.4011	4.74	1.5560	5.42	1.6900	6.10	1.8082
1.35	.3001	2.03	.7080	2.71	.9969	3.39	1.2208	4.07	1.4036	4.75	1.5581	5.43	1.6919	6.11	1.8099
1.36	.3074	2.04	.7129	2.72	1.0006	3.40	1.2237	4.08	1.4060	4.76	1.5602	5.44	1.6937	6.12	1.8115
1.37	.3148	2.05	.7178	2.73	1.0043	3.41	1.2267	4.09	1.4085	4.77	1.5623	5.45	1.6956	6.13	1.8131
1.38	.3220	2.06	.7227	2.74	1.0079	3.42	1.2296	4.10	1.4109	4.78	1.5644	5.46	1.6974	6.14	1.8148
1.39	.3293	2.07	.7275	2.75	1.0116	3.43	1.2325	4.11	1.4134	4.79	1.5665	5.47	1.6992	6.15	1.8164
1.40	.3364	2.08	.7323	2.76	1.0152	3.44	1.2354	4.12	1.4158	4.80	1.5686	5.48	1.7011	6.16	1.8180
1.41	.3435	2.09	.7371	2.77	1.0188	3.45	1.2387	4.13	1.4182	4.81	1.5706	5.49	1.7029	6.17	1.8196
1.42	.3506	2.10	.7419	2.78	1.0224	3.46	1.2412	4.14	1.4206	4.82	1.5727	5.50	1.7047	6.18	1.8213
1.43	.3576	2.11	.7466	2.79	1.0260	3.47	1.2441	4.15	1.4231	4.83	1.5748	5.51	1.7065	6.19	1.8229
1.44	.3646	2.12	.7514	2.80	1.0296	3.48	1.2470	4.16	1.4255	4.84	1.5769	5.52	1.7083	6.20	1.8245
1.45	.3715	2.13	.7561	2.81	1.0331	3.49	1.2499	4.17	1.4279	4.85	1.5789	5.53	1.7101	6.21	1.8261
1.46	.3784	2.14	.7608	2.82	1.0367	3.50	1.2527	4.18	1.4303	4.86	1.5810	5.54	1.7119	6.22	1.8277
1.47	.3852	2.15	.7654	2.83	1.0402	3.51	1.2556	4.19	1.4327	4.87	1.5830	5.55	1.7137	6.23	1.8293
1.48	.3920	2.16	.7701	2.81	1.0438	3.52	1.2584	4.20	1.4350	4.88	1.5851	5.56	1.7155	6.24	1.8309
1.49	.3987	2.17	.7747	2.85	1.0473	3.53	1.2612	4.21	1.4374	4.89	1.5870	5.57	1.7173	6.25	1.8325
1.50	.4054	2.18	.7793	2.86	1.0508	3.54	1.2641	4.22	1.4398	4.90	1.5892	5.58	1.7191	6.26	1.8341
1.51	.4121	2.19	.7839	2.87	1.0543	3.55	1.2669	4.23	1.4422	4.91	1.5912	5.59	1.7209	6.27	1.8357
1.52	.4187	2.20	.7884	2.88	1.0577	9.56	1.2697	4.24	1.4445	4.92	1.5933	5.60	1.7227	6.28	1.8373
1.53	.4252	2.21	.7929	2.89	1.0612	3.57	1.2725	4.25	1.4469	4.93	1.5953	5.61	1.7245	6.29	1.8389
1.54	.4317	2.22	.7975	2.90	1.0647	3.58	1.2753	4.26	1.4492	4.94	1.5973	5.62	1.7263	6.30	1.8405
1.55	.4382	2.23	.8021	2.91	1.0681	3.59	1.2781	4.27	1.4516	4.95	1.5993	5.63	1.7281	6.31	1.8421
1.56	.4446	2.24	.8064	2.92	1.0715	3.60	1.2809	4.28	1.4539	4.96	1.6014	5.64	1.7298	6.32	1.8437
1.57	.4510	2.25	.8109	2.93	1.0750	3.61	1.2837	4.29	1.4562	4.97	1.6034	5.65	1.7316	6.33	1.8453
1.58	.4574	2.26	.8153	2.94	1.0784	3.62	1.2864	4.30	1.4586	4.98	1.6054	5.66	1.7334	6.34	1.8468
1.59	.4637	2.27	.8197	2.95	1.0818	3.63	1.2892	4.31	1.4609	4.99	1.6074	5.67	1.7351	6.35	1.8484
1.60	.4700	2.28	.8241	2.96	1.0851	3.64	1.2919	4.32	1.4632	5.00	1.6094	5.68	1 7369	6.36	1.8500
1.61	.4762	2.29	.8285	2.97	1.0885	3.65	1.2947	4.33	1.4655	5.01	1.6114	5.69	1.7387	6.37	1.8515
1.62	.4824	2.30	.8329	2.98	1.0919	3.66	1.2974	4.34	1.4678	5.02	1.6134	5.70	1.7404	6.38	1.8531
1.63	.4885	2.31	.8372	2.99	1.0952	3.67	1.3001	4.35	1.4701	5.03	1.6154	5.71	1.7422	6 39	1.8547
1.64	.4946	2.32	.8415	3.00	1.0986	3.68	1.3029	4.36	1.4724	5.04	1.6174	5.72	1.7439	6.40	1.8562
1.65	.5007	2.33	.8458	3.01	1.1019	3.69	1.3056	4.37	1.4747	5.05	1.6193	5.73	1.7457		
1.66	.5068	2.34	.8501	3.02	1.1052	3.70	1.3083	4.38	1.4778	5.06	1.6213	5.74	1.7474		
1.67	.5128	2.35	.8544	3.03	1.1085	3.71	1.3110	4.39	1.4793	5.07	1.6233	5.75	1.7491		
1.68	.5187	2.36	.8586	3.04	1.1118	3.72	1.3137	4.40	1.4816	5.08	1.6253	5.76	1.7509		

in. diameter, which has 201 square inches area, would produce an effect equal to 54.95 × 201 = 11,044.9 lbs. Therefore, if the piston moves two feet, it would exert 11,044.9 × 2 = 22,089.8 foot pounds of work at each stroke. Supposing though, that instead of cutting off steam at one-quarter of the stroke and then allowing it to expand, that steam had been admitted until the piston had reached the end of the cylinder. The pressure through the whole stroke would then have been 100 lbs. absolute, or 85 lbs. effective, and the amount of work done during one stroke of two feet, would be 95 × 201 × 2 = 38,190 foot pounds. It must be noted that in the first instance, only one-quarter of a cylinderful of live steam was used, and in the second the whole cylinder was filled from the boiler, so that by using the steam expansively *one-quarter of a cylinderful did eleven nineteenths, or nearly one-half as much work as a whole cylinderful of the same pressure which was not expanded.* On the other hand, if steam of a pressure equal to the *average* pressure is worked full stroke, it would exert exactly the same force on the piston as the steam of higher tension did when working expansively, but in the latter case, when the piston reaches the end of the stroke, the *final pressure*, as it is called, would be considerably lower than in the other. The expansive force

PROPERTIES OF SATURATED STEAM.

Total pressure per sq. inch, measured from a vacuum..........	Pressure above the atmosphere........	Sensible temperature in Fahrenheit degrees..............	Total heat in degrees from zero of Fahrenheit..............	Weight of one cubic foot of steam........	Relative volume of the steam compared with the water from which it was raised........	Total pressure per sq. inch, measured from a vacuum..........	Pressure above the atmosphere........	Sensible temperature in Fahrenheit degrees..............	Total heat in degrees from zero of Fahrenheit..............	Weight of one cubic foot of steam........	Relative volume of the steam compared with the water from which it was raised........
Lb.	Lb.	Deg.	Deg	Lb.		Lb	Lb.	Deg.	Deg.	Lb.	
1	..	102.1	1144.5	.0030	20582	86	71.3	316.9	1210.1	.2002	311
2	..	126.3	1151.7	.0058	10721	87	72.3	317.8	1210.4	.2024	308
3	..	141.6	1156.6	.0085	7322	88	73.3	318.6	1210.6	.2044	305
4	..	153.1	1160.1	.0112	5583	89	74.3	319.4	1210.9	.2067	301
5	..	162.3	1162.9	.0138	4527	90	75.3	320.2	1211.1	.2089	298
6	..	170.2	1165.3	.0163	3813	91	76.3	321.0	1211.3	.2111	295
7	..	176.9	1167.3	.0189	3298	92	77.3	321.7	1211.5	.2133	292
8	..	182.9	1169.2	.0214	2909	93	78.3	322.5	1211.8	.2155	289
9	..	188.3	1170.8	.0239	2604	94	79.3	323.3	1212.0	.2176	286
10	..	193.3	1172.3	.0264	2358	95	80.3	324.1	1212.3	.2198	283
11	..	197.8	1173.7	.0289	2157	96	81.3	324.8	1212.5	.2219	281
12	..	202.0	1175.0	.0314	1986	97	82.3	325.6	1212.8	.2241	278
13	..	205.9	1176.2	.0338	1842	98	83.3	326.3	1213.0	.2263	275
14	..	209.6	1177.3	.0362	1720	99	84.3	327.1	1213.2	.2285	272
14.	0.	212.0	1178.1	.0380	1642	100	85.3	327.9	1213.4	.2307	270
15	.3	213.1	1178.4	.0387	1610	101	86.3	328.5	1213.6	.2329	267
16	1.3	216.3	1179.4	.0411	1515	102	87.3	329.1	1213.8	.2351	265
17	2.3	219.6	1180.3	.0435	1431	103	88.3	329.9	1214.0	.2373	262
18	3.3	222.4	1181.2	.0459	1357	104	89.3	330.6	1214.2	.2393	260
19	4.3	225.3	1182.1	.0483	1290	105	90.3	331.3	1214.4	.2414	257
20	5.3	228.0	1182.9	.0507	1229	106	91.3	331.9	1214.6	.2435	255
21	6.3	230.6	1183.7	.0531	1174	107	92.3	332.6	1214.8	.2456	253
22	7.3	233.1	1184.5	.0555	1123	108	93.3	333.3	1215.0	.2477	251
23	8.3	235.5	1185.2	.0580	1075	109	94.3	334.0	1215.3	.2499	249
24	9.3	237.8	1185.9	.0601	1036	110	95.3	334.6	1215.5	.2521	247
25	10.3	240.1	1186.6	.0625	996	111	96.3	335.3	1215.7	.2543	245
26	11.3	242.3	1187.3	.0650	958	112	97.3	336.0	1215.9	.2564	243
27	12.3	244.4	1187.8	.0673	926	113	98.3	336.7	1216.1	.2586	241
28	13.3	246.4	1188.4	.0696	895	114	99.3	337.4	1216.3	.2607	239
29	14.3	248.4	1189.1	.0719	866	115	100.3	338.0	1216.5	.2628	237
30	15.3	250.4	1189.8	.0743	838	116	101.3	338.6	1216.7	.2649	235
31	16.3	252.2	1190.4	.0766	813	117	102.3	339.3	1216.9	.2674	233
32	17.3	254.1	1190.9	.0789	789	118	103.3	339.9	1217.1	.2696	231
33	18.3	255.9	1191.5	.0812	767	119	104.3	340.5	1217.3	.2738	229
34	19.3	257.6	1192.0	.0835	746	120	105.3	341.1	1217.4	.2759	227
35	20.3	259.3	1192.5	.0858	726	121	106.3	341.8	1217.6	.2780	225
36	21.3	260.9	1193.0	.0881	707	122	107.3	342.4	1217.8	.2801	224
37	22.3	262.6	1193.5	.0905	688	123	108.3	343.0	1218.0	.2822	222
38	23.3	264.2	1194.0	.0929	671	124	109.3	343.6	1218.2	.2845	221
39	24.3	265.8	1194.5	.0952	655	125	110.3	344.2	1218.4	.2867	219
40	25.3	267.3	1194.9	.0974	640	126	111.3	344.8	1218.6	.2889	217
41	26.3	268.7	1195.4	.0996	625	127	112.3	345.4	1218.8	.2911	215
42	27.3	270.2	1195.8	.1020	611	128	113.3	346.0	1218.9	.2933	214
43	28.3	271.6	1196.2	.1042	598	129	114.3	346.6	1219.1	.2955	212
44	29.3	273.0	1196.6	.1065	585	130	115.3	347.2	1219.3	.2977	211
45	30.3	274.4	1197.1	.1089	572	131	116.3	347.8	1219.5	.2999	209
46	31.3	275.8	1197.5	.1111	561	132	117.3	348.3	1219.6	.3020	208
47	32.3	277.1	1197.9	.1133	550	133	118.3	348.9	1219.8	.3040	206
48	33.3	278.4	1198.3	.1156	539	134	119.3	349.5	1220.0	.3060	205
49	34.3	279.7	1198.7	.1179	529	135	120.3	350.1	1220.2	.3080	203
50	35.3	281.0	1199.1	.1202	518	136	121.3	350.6	1220.3	.3101	202
51	36.3	282.3	1199.5	.1224	509	137	122.3	351.2	1220.5	.3121	200
52	37.3	283.5	1199.9	.1246	500	138	123.3	351.8	1220.7	.3142	199
53	38.3	284.7	1200.3	.1269	491	139	124.3	352.4	1220.9	.3162	198
54	39.3	285.9	1200.6	.1291	482	140	125.3	352.9	1221.0	.3184	197
55	40.3	287.1	1201.0	.1314	474	141	126.3	353.5	1221.2	.3206	195
56	41.3	288.2	1201.3	.1336	466	142	127.3	354.0	1221.4	.3228	194
57	42.3	289.3	1201.7	.1364	458	143	128.3	354.5	1221.6	.3250	193
58	43.3	290.4	1202.0	.1380	451	144	129.3	355.0	1221.7	.3273	192
59	44.3	291.6	1202.4	.1403	444	145	130.3	355.6	1221.9	.3294	190
60	45.3	292.7	1202.7	.1425	437	146	131.3	356.1	1222.0	.3315	189
61	46.3	293.8	1203.1	.1447	430	147	132.3	356.7	1222.2	.3336	188
62	47.3	294.8	1203.4	.1469	424	148	133.3	357.2	1222.3	.3357	187
63	48.3	295.9	1203.7	.1493	417	149	134.3	357.8	1222.5	.3377	186
64	49.3	296.9	1204.0	.1516	411	150	135.3	358.3	1222.7	.3397	184
65	50.3	298.0	1204.3	.1538	405	155	140.3	361.0	1223.5	.3500	179
66	51.3	299.0	1204.6	.1560	399	160	145.3	363.4	1224.2	.3607	174
67	52.3	300.0	1204.9	.1583	393	165	150.3	366.0	1224.9	.3714	169
68	53.3	300.9	1205.2	.1605	388	170	155.3	368.2	1225.7	.3821	164
69	54.3	301.9	1205.5	.1627	383	175	160.3	370.8	1226.4	.3928	159
70	55.3	302.9	1205.8	.1648	378	180	165.3	372.9	1227.1	.4035	155
71	56.3	303.9	1206.1	.1670	373	185	170.3	375.3	1227.8	.4142	151
72	57.3	304.8	1206.3	.1692	368	190	175.3	377.5	1228.5	.4250	148
73	58.3	305.7	1206.6	.1714	363	195	180.3	379.7	1229.2	.4357	144
74	59.3	306.6	1206.9	.1736	359	200	185.3	381.7	1229.8	.4464	141
75	60.3	307.5	1207.2	.1759	853	210	195.3	386.0	1231.1	.4668	135
76	61.3	308.4	1207.4	.1782	349	220	205.3	389.9	1232.3	.4872	129
77	62.3	309.3	1207.7	.1804	345	230	215.3	393.8	1233.5	.5072	123
78	63.3	310.2	1208.0	.1826	341	240	225.3	397.5	1234.6	.5270	119
79	64.3	311.1	1208.3	.1848	337	250	235.3	401.1	1235.7	.5471	114
80	65.3	312.0	1208.5	.1869	333	260	245.3	404.5	1236.8	.5670	110
81	66.3	312.8	1208.8	.1891	329	270	255.3	407.9	1237.8	.5871	106
82	67.3	313.6	1209.1	.1913	325	280	265.3	411.2	1238.8	.6070	102
83	68.3	314.5	1209.4	.1935	321	290	275.3	414.4	1239.8	.6268	99
84	69.3	315.3	1209.6	.1957	318	300	285.3	417.5	1240.7	.6469	96
85	70.3	316.1	1209.9	.1980	314						

of steam represents *energy*, or *capacity for doing work*, and, therefore, if we allow it to escape with a comparatively high pressure without doing work, it is a waste of energy. To illustrate this, we will take the same conditions which were used in the answer to question 87, in calculating the average pressure. In that case, the mean absolute pressure of the steam was 69.95 lbs. per square in., but the pressure at the end of the stroke, when the steam escaped, was only $33\frac{2}{3}$ lbs. absolute. If, therefore, steam had been used of the average pressure through the whole stroke, it would have escaped with a pressure of 69.95 lbs., or more than twice that of the expanded steam, and the work done in both cases would have been the same.

QUESTION 93. *Can the economy of working steam expansively be shown in any other way?*

Answer. Yes, it can be shown if we know the "total heat" contained in a given quantity of steam used expansively and that in steam which has been used without expansion, and then compare the two quantities with the amount of work done under the two different conditions.

For the basis of the circulations the same data and dimensions will be employed that were used in the previous illustration; that is, a cylinder of 16 in. diameter, and piston with 24 in. stroke, and steam of 100 lbs. absolute pressure cut off at 8 in. of the stroke. We will suppose, further, that the steam used is generated from water of a temperature of 60 degrees, and we will then calculate the total number of units of heat in the steam used for each stroke of the piston. The area of a piston 16 in. in diameter is 201 square in.; and as the steam is admitted until the piston moves 8 in. of its stroke, therefore the quantity of steam would be 8 times 201 cubic in., or

$$201 \times 8 = 1608 \text{ cubic in.} = \frac{1608}{1728} \text{ cubic ft.}$$

From the table it will be seen that one cubic foot of steam of 100 lbs. pressure weighs 0.2307 lbs.; therefore, the weight of the fraction of a cubic foot given above would be calculated as follows:

$$\frac{.2307 \times 1608}{1728} = .2146 \text{ lbs.} = \text{weight of 1608 cubic in. of steam}$$

of 100 lbs. absolute pressure.

From the table it will be seen that the total heat above zero of steam of 100 lbs. absolute pressure is 1213.4 degrees. It was explained in the answer to question 57 that one pound of water heated one degree is the standard of measurement or *unit of heat*. Now, if we have 1 lb. of water with a temperature of zero, evidently it will take 1213.4 *units of heat* to convert it into steam of 100 lbs. absolute pressure. But as the water from which our steam was generated had a temperature of 60 degrees, we must deduct that much from 1213.4: $1213.4 - 60. = 1153.4$ = units of heat in one pound of steam of 100 lbs. absolute pressure generated from water of 60 degrees temperature.

If then one pound of steam has 1153.4 units of heat, the following calculation will give the units of heat in .2146 lbs.: $1153.4 \times .2146 = 247.51$ = units of heat in .2146 lbs., or 1,608 cubic in. of steam of 100 lbs. absolute pressure. It was shown in answer to question 94 that the average pressure of steam of 100 lbs. cut off at 8 in. of the stroke was 69.95 lbs. per square inch. So that if steam of 100 lbs. absolute pressure is used expansively it requires 247.51 units of heat to produce an average absolute pressure of 69.95 lbs. per square in. during the whole stroke. Disregarding the small fraction, we will call it 70 lbs. Now, if we admit steam of this pressure through the *whole stroke* of the piston, we will use 4,824 cubic in. It will be found by a calculation similar to the above, that to generate this quantity of steam of 70 lbs. pressure from water of a temperature of 60 degrees would require 527 units of heat, or more than twice as many as were required to do the same work with steam of 100 lbs. pressure cut off at 8 in. when using it expansively during the rest of the stroke. The actual difference in practice is not so great as this, because the loss of heat from radiation and condensation in the cylinder and other causes is greater when steam of a high pressure is expanded than when lower pressure steam is admitted through the whole stroke. But after allowance is made for all such sources of loss and waste, there is still a great gain from using steam expansively. There is is also an incidental advantage, because low-pressure steam can be exhausted more quickly from a cylinder than steam of a high pressure, and consequently there is less resistance or *back pressure*, as it is called, in the exhausted end of the cylinder to the movement of the piston.

The causes which produce the greatest economy when steam is used expansively cannot be fully explained, however, without discussing principles of science more abstruse than it is desirable to introduce here.

QUESTION 94. *To what extent can we work steam expansively with advantage and economy?*

Answer. The theoretical economy of using steam increases with the degree of expansion and the pressure. This is shown very clearly in the following table, in the first column of which the number of inches of the piston stroke is given during which steam is admitted to a cylinder 16 in. in diameter and 24-in. stroke. In the second column is given the pressure of the steam or *initial pressure*, as it is called, which must be admitted into the cylinder in order to produce a mean pressure of 70 lbs. per square inch when it is cut off at the point indicated in the first column. In the third column is given the total heat which is required to generate the steam required in each case, and in the last column the percentage of saving is given, which results from the different degrees of expansion and a mean pressure of 70 lbs. per square in. in each case.

RESULTS OF USING STEAM EXPANSIVELY.

Period of admission or point of cut-off.	Initial pressure of steam in pounds per square inch.	Total heat of steam used, in units.	Percentage of saving compared with full stroke.
Full stroke........	70.	527.	
18 in. = Three-quarters of the stroke	72.5	408.7	$22\frac{1}{2}$
12 in. = One-half " "	82.7	309.5	$41\frac{1}{4}$
8 in. = One-third " "	100.	247.5	53
6 in. = One-quarter " "	117.4	215.9	58
4 in. = One-sixth " "	150.5	186.5	$64\frac{1}{2}$
3 in. = One-eighth " "	181.8	165.8	$68\frac{1}{2}$
2 in. = One-twelfth " "	241.4	144.8	$72\frac{1}{2}$

From this table it will be seen that theoretically $22\frac{1}{2}$ per cent. of heat is saved by cutting off at $\frac{3}{4}$ of the stroke and using steam of 72.5 lbs. pressure instead of steam of 70 lbs., worked full stroke. Cutting off at half-stroke and using steam of 82.7 lbs., $41\frac{1}{4}$ per cent. of heat is saved, and cutting off at quarter-stroke with steam of 117.4 lbs., saves 58 per cent. of heat; and at one-twelfth of the stroke, or expanding steam of 241.4 lbs. pressure to twelve times its volume, saves $72\frac{1}{2}$ per cent of heat.

As stated before, the above is the *theoretical* advantage of using steam expansively. There are, however, practical difficulties in the way of using some of these high degrees of expansion. It has already been explained that, if steam is cut off early in the stroke and the degree of expansion increased, the pressure and consequently the temperature of the steam must also be increased. The danger of explosion is greater with the higher pressures, and stronger and more expensive boilers and machinery are therefore needed. With steam of very high temperature the metal of the cylinders, pistons and valves becomes so much heated that they soften, and then the friction of the one on the other causes them to cut or scratch each other. The high temperature at the same time destroys the oil or other lubricant used in contact with the steam. It is also impossible to admit and cut off steam very early in the stroke with the ordinary mechanical appliances used for moving slide-valves of locomotives. This latter difficulty and the effect of expansion in equalizing the pressure in the crank and lessening the strains and shocks on the mechanism of the engine will be more fully explained hereafter.

QUESTION 95. *How may the amount of expansion that can be made practically useful be illustrated and explained?*

Answer. It was shown in answer to question 90, that the main effective pressure represented by the indicator card shown in fig. 47, if steam of 100 lbs. pressure is admitted into the cylinder during one-third of the stroke, and it is allowed to expand during the rest of the stroke, will be 54.95 lbs. per square inch. As the stroke of the piston is 2 feet, the number of foot-pounds of work which would be exerted for each square inch of area of the piston during each stroke would be $54.95 \times 2 = 109.9$. Let *i j n o p*, Fig. 48, represent this card, and we will suppose that the cylinder is lengthened so that the piston will have 4 ft. stroke instead of 2 ft., and that the steam is expanded six times instead of three times. The indicator diagram which the steam would then make would be represented by *i j n k p*. By calculating the mean effective pressure for the whole stroke of 4 ft., in the manner already described, it will be found to be 31.53 lbs. As this pressure is exerted through 4 ft. of stroke, the work done per square inch of piston will be $31.53 \times 4 = 126.12$ foot-pounds or a gain of nearly 15 per cent. It should be observed that to secure this economy the cylinder and a number of other parts of the engine must be doubled in size.

QUESTION 96. *What will be the result, if, instead of increasing the size of the cylinder and rate of expansion, we double the "initial pressure"* of the steam which is introduced into the cylinder, and then cut it off at one-sixth of the stroke instead of one-third?*

Answer. The effect of this can be shown if we draw a diagram, *l m n o p*, in which the initial pressure represented by the height *l p* is 200 lbs. absolute, instead of 100, and the steam is supposed to be cut off at *m*, or at 4 in. of the stroke, instead of 8, and the piston to have a stroke, *p o*, of 2 ft. If the average pressure is then calculated as before, it will be found to be

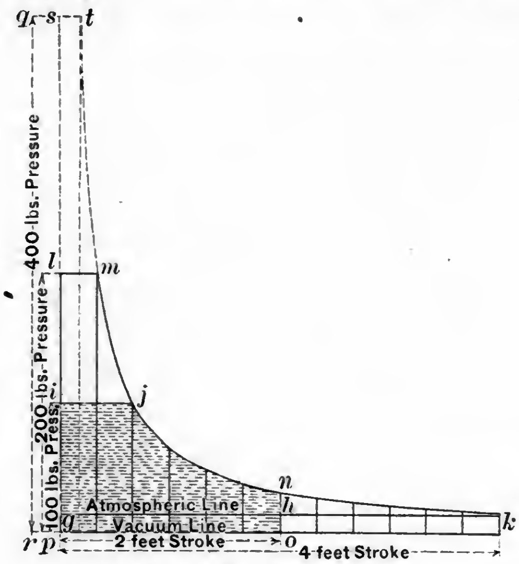


Fig. 48

78.06 lbs. per square inch, so that the work done for each square inch of area of the piston during each stroke will be 156.12 foot lbs. instead of 109.9, or a gain of over 42 per cent., with steam of 100 lbs. pressure expanded three times. By referring to the table of the properties of steam it will be seen that with 100 lbs. pressure the total heat is 1213.4, and with 200 it is 1229.8 a difference of 16.4 degrees or units or only a little over 1⅓ per cent. more. That is, theoretically, by adding 1⅓ per cent. more heat to the steam and expanding it twice as much, there is a gain of 42 per cent. in the amount of work done. To do this, though, the boiler and engine must be made twice as strong to resist these high pressures.

We may assume still further that the stroke is lengthened, and the steam of 200 lbs. pressure is expanded twelve times, as indicated by the diagram *l m k p*, and also that the pressure is increased to 400 lbs. and the steam expanded to twelve times, as shown by the diagram *s t m n o p*, or twenty-four times as represented by *s t k p*. In the following table the calculated results from these high pressures and rates of expansion are given:

1	2	3	4	5	6	7	8	9
	Initial Pressure in lbs. per square inch.	Rate of expansion.	Average cylinder pressure.	Foot lbs. of work done per stroke for each inch in area of cylinder.	Percentage of gain.	Boiler strength of	CYLINDER. Size of	CYLINDER. Strength of
a	100	3	54.95	109.09		1	1	1
b	100	6	31.53	126.12	15	1	2	1
c	200	6	78.06	156.12	42	2	1	2
d	200	12	43.08	172.32	57	2	2	2
e	400	12	101.00	202.00	83	4	4	2
f	400	24	54.6	218.4	100	4	4	4

Column 5 shows the gain in foot-pounds of work done per square inch of piston, and from the increased steam pressure and higher rates of expansion. Column 6 gives the percentage of gain in the work done when compared with the results with steam of an initial pressure of 100 lbs expanded three times. Columns 7, 8 and 9 give the relative strength of the results with steam of an initial pressure of 100 lbs. expanded boiler and size and strength of cylinder required in each case. From the line *b* it will be seen that, by doubling the rate of expansion, there is a gain of 15 per cent., but the cylinder must then be twice as large as before. This means an increase in size and strength of other parts. To gain 42 per cent., by doubling the pressure and rate of expansion as shown in the line marked *c*, the boiler and cylinder must both be doubled in strength. A gain of 57 per cent., by doubling the pressure and quadrupling the rate of expansion, requires the strength of boiler and size and strength of engine all to be doubled, and the gain of 100 per cent. in the last line compels the strength of boiler and strength and size of cylinder all to be quadrupled. From this table it is obvious that we soon reach a point at which increasing the steam pressure and rate of expansion involves so much expense for the larger size and strength of boiler and engine, that the gain in the work done will not pay for the increased cost.

*The pressure of the steam when it is first admitted to the cylinder and before it is cut off is called the *initial pressure.*

QUESTION 97. *Can as much be gained practically from increased rates of expansion, as the preceeding examples have indicated was possible?*

Answer. No. In every engine there is always a very considerable loss of heat from radiation, conduction, and from the conversion of heat into work, and probably from causes not yet perfectly understood.

QUESTION 98. *What can be done to lessen this loss of heat?*

Answer. The most important thing to do is to cover the boiler, cylinders and steam-pipes with the most perfect non-conductor of heat that can be used.

QUESTION 99. *What other reasons are there why very high degrees of expansion are not practicable on locomotives?*

Answer. There is the difficulty that the valve-gear which is now generally used will not admit steam freely to the cylinders and cut it off short: and next, high rates of expansion require either large cylinders or high initial pressure. In either case, it means that the propelling force, exerted to turn the wheels will be excessive during some portions of each revolution of the wheels, and will thus cause them to slip. This will be explained in a future chapter.

QUESTION 100. *What is meant by wire-drawn steam?*

Answer. It is steam which has had its pressure reduced by passing through contracted openings or passages.

QUESTION 101. *What is the economical effect of reducing the pressure, or of wire-drawing it, by partly closing the valve by which it admitted to the cylinders.*

Answer. By reducing the pressure of steam in this or any other way, it is necessary in doing the same amount of work to admit steam to the cylinder for a longer period, and, therefore, to reduce the degree of expansion. To illustrate the effect of this, we will estimate the total heat required to exert a pressure of 70 lbs. on the piston described above. It will be assumed that the steam pressure in the boiler is 100 lbs. absolute, and that this is wire-drawn down to 70 lbs. and admitted to the cylinder through the whole stroke. As was shown in the preceding answer, 4,824 cubic in. of steam are required to fill the cylinder. Now, 3,376.8 cubic in. of steam of 100 lbs. pressure, if expanded to 70 lbs. pressure, will make 4,824 cubic in. The total heat required to generate 3,376.8 cubic in. of steam of 100 lbs. absolute pressure from water of 60 degrees is 519.9 units, so that to do the same work by using steam of *high-pressure cut-off at one-third of the stroke*, using steam of *low boiler pressure full stroke*, and using *wire-drawn steam full stroke*, would, in the example we have selected, require 247.5, 527 and 519.9 units of heat respectively.

(TO BE CONTINUED.)

OBITUARY.

JOSEPH CURTIS PLATT, who died in Scranton, Pa., November 15, was one of the founders of that city. He was born at Saybrook, Conn., in 1816, and went to Pennsylvania in 1846. In 1851, he joined with Joseph H. and E. C. Scranton in business, and in 1853 assisted in organizing the Lackawanna Iron & Coal Company, of which he was Vice-President for many years. He retired from business in 1875, but was still a director in his old company, in the Dickson Manufacturing Company and several other corporations, and took an active interest in their management.

PROFESSOR GUSTAV KIRCHHOFF, who died recently at Berlin, Germany, aged 63 years, held a very high place in the scientific world. His remarkable works in the department of physical science, especially in relation to light and elecicity, are standards both for students and

for other investigators. His name will be perpetuated by his discoveries in relation to the dark lines of the spectrum, or the lines of Frauenhofer, as they are called. The laws of the propagation of the electric current, extensions of the laws of Ohm, are universally known in Europe as the laws of Kirchhoff. Herr Kirchhoff was Professor of Physics at the University of Berlin; a member of the Imperial Academy of Science, corresponding member of the French Academy of Science and of many other scientific bodies.

DAVID MORGAN, President and General Manager of the Republic Iron Company, whose mine is situated near Marquette, Mich., and one of the richest men in the iron world, died October 30, at Asheville, N. C., where he was taken by his physicians in the hope of saving his life. Mr. Morgan was born in Swansea, Wales, in 1819, and went to Pennsylvania with his parents when 17 years old. He began as a miner in the coal mines, then became an operator, and finally an extensive employer in the coal and iron business in Ironton, O. He moved to Marquette, Mich., in 1875, and had since given his entire time to his great mine, in which he became a stockholder when the stock was almost valueless, seeing it go up to nearly $200 a share on a par value of $25. He leaves an only child, Mrs. Charles Hebard, of Pequaming, Mich. The remains were buried at Wilkes-Barre, Pa., Mr. Morgan's old home.

MAJOR ALFRED MORDECAI, who died in Philadelphia, October 23, aged 83 years, graduated from West Point in 1823, at the head of his class. He served in the Engineer Corps and the Ordnance Corps, rising to the rank of Major; he resigned in 1861. From 1863 to 1866 he was Assistant Engineer of the proposed Mexico & Pacific road, and in 1867 he was made Secretary and Treasurer of the Pennsylvania Canal Company, holding that position till his death. He was author of "Reports of Experiments on Gunpowder," 1845 and 1849; of "Artillery for the United States Land Service, as Devised and Arranged by the Ordnance Board, with Plates," 1849, and of the "Ordnance Manual, for the Use of the Officers of the United States Army" (second edition), 1850. Major Mordecai was a man of the highest order of talent and an officer of marked professional ability and experience. His "Reports of Experiments on Gunpowder" were a great advance on the knowledge possessed 40 years ago; and even at this day, notwithstanding modern improvements, those reports are classics in every military library. His "Artillery for the Land Service" and the "Ordnance Manual" were text books in the Army long before the advent of steel guns and steel carriages, brown powder and explosive gelatine. Modern methods and advances, new materials and explosives and newly developed forces may seem to dwarf the appliances and knowledge of the first half of our century, but at that time Major Mordecai's attainments were second to none in the military world in the field of scientific research and accomplishment and in practical application of mechanical deductions to war uses.

DR. THOMAS USTICK WALTER, who died in Philadelphia, October 30, was the oldest and most distinguished architect in that city, and one of the best known in the United States. He was born in Philadelphia in 1804, and studied architecture under Mr. William Strickland and afterward mathematics under David McClure, then distinguished as a teacher of that science. He applied himself assiduously to study for many years before he commenced the practice of his profession. He designed in 1831 and superintended the erection of the Philadelphia county prison. His designs for the Girard College were adopted by City Councils in 1833, and that magnificent building, perhaps the finest specimen of classic architecture on the American continent, was constructed throughout from Mr. Walter's designs and under his immediate supervision. This work occupied him for 14 years. In 1851, Mr. Walter's plans for the extension for the Capitol at Washington were adopted, and he was appointed Architect of the work by President Fillmore, a position which he held for 14 years. In addition to the work of the Capitol extension he planned and executed the new dome of the Capitol, the east and west wings of the Patent Office and the extension of the General Post Office. He also designed the new Treasury building and the Government Hospital for the Insane. During the latter years of his life Mr. Walter acted as assistant to Architect McArthur at the new public buildings, Philadelphia. In 1853, Mr. Walter received the title of Doctor of Philosophy from the University of Lewisburg, and in 1857 that of Doctor of Laws from Harvard University. He held for many years a professorship of architecture in the Franklin Institute, and was a member of the American Philosophical Society and of many other literary and scientific institutions. He was one of the founders of the American Institute of Architects, and at the last meeting of that body, a short time since, resigned its active Presidency. He was, however, elected Honorary President. The deceased was a member and one of the deacons of Memorial Baptist Church, in Philadelphia. In later years he became a Mason, and was a member of Columbia Lodge, F. and A. M. He leaves a widow, the daughter of the late Dr. Richard Gardner, of Philadelphia, and a number of sons and daughters.

The Siemens Regenerating Furnace.

IN Washington, November 14, a decision was rendered by the United States Supreme Court in the case of Charles W. & Frederick Siemens, appellants, against William Sellers and others; appeal from the Circuit Court of the United States for the Eastern District of Pennsylvania. This is a suit for alleged infringement of a patent granted to the Siemens Brothers, of England, upon their well-known regenerating furnace. The defendants do not deny that the Siemens Brothers were the authors of the ingenious invention covered by the patent, nor do they deny they use it. Their contention is that the Siemens Brothers took out an English patent for the same invention on July 19, 1861, and that by force of the acts of 1839 and 1861 the American patent expired at the end of 17 years from the sealing of the English patent, namely, on July 19, 1878. They deny that they used the said invention before the last mentioned date, and no evidence is given that they did so. The questions to be decided, therefore, are whether the English patent was for the same invention as the American patent and, if so, whether the latter was limited to expire at the end of 17 years from the sealing of the former. The Court holds that both of these questions must be answered in the affirmative, and it therefore sustains the decree of the Circuit Court in favor of the American users of the Siemens invention. The opinion was drawn up by Justice Bradley.

Manufacturing Notes.

BLAINE BROTHERS have completed shops at Green Cove Springs, Fla., with a capacity of two box cars a day.

THE Harrisburg Car Manufacturing Company has received an order for 1,150 new freight cars for the Philadelphia & Reading Railroad.

THE Atlanta Car Company has been organized in Atlanta, Ga., with $100,000 capital, and will build car shops at once. C. F. Lucas, late of the car shops at Anniston, Ala., is Superintendent.

THE Massillon Bridge Company at Massillon, O., has taken a contract to build an iron bridge, 250 ft. long, over the Embarrass River near Newton, Ill., for the Indiana & Illinois Southern Railroad.

THE St. Charles Car Company in St. Charles, Mo., includes among recent orders 7 passenger cars for the St. Louis, Alton & Terre Haute; 250 box cars for the Mexican Central, and 600 coal cars for the Atchison, Topeka & Santa Fe.

THE Decatur Car Wheel & Spring Company has been organized at Decatur, Ala., and has begun to build a car-wheel foundry. A shop for making springs is to be added. E. Stanley Mitchell, of Milwaukee, Wis., is President; R. M. McCullough, Secretary and Treasurer.

Proceedings of Societies.

International Railroad Congress.

THE second meeting of the International Railroad Congress, which was held at Milan, Italy, in October, brought together a large number of railroad men from all parts of Europe. The chief technical subjects discussed were the use of metal ties; the construction of passenger cars; the use of continuous brakes; the use of iron or steel for bridges; journal-boxes and lubrication, and the lighting of trains and stations. In relation to the operation of railroads reports were submitted and discussions held of the best methods of working secondary (branch or light feeder) railroads; the control of passenger traffic; co-operative associations for employés, and the employment of women on railroads.

The questions which called out the most discussion, apparently, were those relating to the building and management of light or secondary railroads as branches and feeders of the main lines, and on these questions there was much difference of opinion.

One question that is now of interest here was discussed at some length—the use of continuous brakes on freight trains. On this point it was agreed that their general introduction would be very difficult, if not impossible, on account of the great dissimilarity in the rolling stock in use in the different countries of Europe.

French is the official language of the Congress, and the English delegates took little part in the proceedings, as most of them were unable to express themselves freely in that language. One or two railroad men from the United States were present as spectators, but the only official delegates from America in the Congress represented Mexico and the Argentine Republic.

The next meeting of the Congress will be held in Paris in 1889.

American Society of Civil Engineers.

AT the regular meeting in New York, November 2, the final report of the Committee on proposed changes in grades of membership was presented, substantially as given in our last issue.

Several amendments in relation to ballots for members were presented.

The following elections were announced:

Members.—George Earl Church, London, Eng.; Henry Stevens Haines, Savannah, Ga.; David Carlisle Humphreys, St. Louis, Mo.; William Datus Kelley, Jr., Tarrytown, N. Y.; Rowland Robinson Minturn, Milwaukee, Wis.; James Moylan, New York; Cornelius Palmer, Escanaba, Mich.; William Barclay Parsons, New York; Edward Fesser Playle, New York; Albert Fowler Robinson, St. Paul, Minn.; Orlando Belina Wheeler, St. Louis, Mo.

Associate.—Arthur James Moxham, Johnstown, Pa.

Juniors.—Archie McLean Hawks, St. Louis, Mo.; Downing Vaux, New York.

A long and interesting paper was presented by L. L. Buck on Replacing the Stone Towers of the Niagara Railroad Suspension Bridge with Iron Towers.

A regular meeting was held November 16, at which papers were read by Mr. C. L. Strobel on Experiments on Z-iron Columns, and also one by Mr. A. P. Boller on Test of a Wrought Iron Double-track Floor Beam. The latter was discussed at some length.

Mr. S. S. Wheeler exhibited a Chart of Wire Gauges, showing the many gauges in use and their differences.

Engineers' Club of St. Louis.

A MEETING was held in St. Louis, November 2, President Potter in the Chair. The Executive Committee submitted the following programme for the meetings of the season:

"November 2.—Chas. E. Jones, Steam Heating at Washington University.

"November 16.—Prof. J. B. Johnson, Testing the Strength of Engineering Materials.

"December 7.—Annual meeting—P. M. Bruner, The Action of Frost on Concrete Work.

"December 21.—Isaac A. Smith, Rapid Railway Embankment Construction.

"January 4.—Chas. H. Ledlie, Construction of Dam and Reservoir at Athens, Ga.; Chas. W. Bryan, Railway-Bridge Designing.

"January 18.—Carl Gayler, Floors of Street Bridges; N. W. Eayrs, The Improvement of Nantucket Harbor, Mass.

"February 1.—Prof. F. E. Nipher, Graphical Solution of the Action of the Series Dynamo; B. F. Crow, Constructive Accounts.

"February 15.—Robert Moore, Sizes of Railroad Culverts; O. L. Petitdidier, Practical Notes on Masonry and Stone Laying.

"March 7.—Prof. H. B. Gale, The Transmission of Power by Belting; Samuel F. Burnet, Cement and Mortar.

"March 21.—Prof. W. B. Potter, St. Louis Water Supply.

"April 4.—S. Bent Russell, Thickness of Water Pipes; H. A. Wheeler [subject not yet announced].

"April 18.—Prof. C. M. Woodward, Gas Producers; Lewis Stockett, A Well-Ventilated Mine.

"May 2.—Col. E. D. Meier, Standards of Boiler Efficiency; Chas. F. White, The Failure of a Firmenich Boiler.

"May 16.—R. E. McMath, the Waterway Between the Lakes and the Mississippi River.

"June 6.—M. L. Holman, The Temporary Low-Service Pumping Plant at St. Louis.

"Partial promises have been made of other papers on topics of interest. These will be presented as opportunity occurs and due notice given."

Professor Johnson read a communication from the Board of Managers of the Association of Engineering Societies on the subject of a closer union between the Societies now in the Association and others. On motion the consideration of this paper was made a special order for the next meeting, November 16.

Mr. Chas. E. Jones then read a paper on Steam Heating at Washington University, and Experience with Underground Pipes. The history of the system in use was given with details of its construction and the work done. It was shown that the boilers were regularly doing double the duty which was originally expected of them. The evaporative efficiency did not seem to be reduced when the boilers were forced in this manner. Great efforts had been made to reduce the smoke, and many devices had been tested. All had failed on account of the excessive duty required of the boilers. The underground pipes had failed after years of service from external corrosion due to the accidental admission of moisture to the conduits. New pipes had been laid recently, and the construction of the new conduit was shown.

Professors Woodward, Potter, Gale and Messrs. Bryan and Sharman took part in the discussion. Mr. Jones added that a new stack had just been erected, which had increased the draft sufficiently to permit the introduction of a small amount of air above the grates. This had resulted in an appreciable reduction of the smoke.

A REGULAR meeting was held November 16. The regular order of the day was taken up, being a communication from the Board of Managers of the Association of Engineering Societies. The discussion was participated in by Col. H. C. Moore, Professors Johnson and Nipher, Messrs. Robert Moore, Russell, Seddon, Ockerson, Bryan and R. E. McMath; also, on invitation, by Mr. A. W. Wright, of Chicago. On motion the following was adopted:

"*Resolved*, That in the opinion of the Engineers' Club of St. Louis an attempt at an organic union is not desirable. We therefore decline to favor the recommendation of the Board of Managers."

The following Committee on Nominations of officers for the coming year was then elected: J. A. Seddon, Chairman; R. E. McMath, S. B. Russell, E. A. Engler, J. A. Ockerson.

Prof. Johnson then read a paper on Testing the Strength of Engineering Materials. His remarks were illustrated by sketches on the board; he also showed numerous test pieces of iron, steel, brick, stone and wood; also a small testing machine as used. The paper was discussed by Messrs. Russell, Moore, Engler, Seddon, Potter and Nipher, the latter exhibiting a cast-iron cup which had been attached to the bottom of a piece of wrought-iron pipe, filled with water, and broken by firing a rifle ball from above into the water.

Western Society of Engineers.

A REGULAR meeting was held in Chicago, November 1. John F. Barney and Jacob Rodatz were elected members. The resignation of Mr. L. P. Morehouse as Secretary was discussed and a committee of three was appointed to prepare some fitting recognition of his services and to appoint a successor.

A display of work by the engineering students of the University of Michigan was made.

Mr. Scherzer presented a written discussion of the paper read by Mr. Lundie at the preceding meeting, on the Economical Height of Bridge Trusses. The paper was discussed orally by Messrs. Artingstall and Strobel.

Western Railway Club.

THE regular monthly meeting was held in Chicago, November 16. The subject of Extension Smoke-boxes and Fire-box arches was opened by Mr. John Hickey, who spoke at some length of the advantages to be gained by their use. The discussion was continued by Messrs. Swanson, Mackenzie, Verbryck, Forsyth, Rhodes and others.

Mr. W. L. Brown read a paper on the Relative Strength of Sap and Heart in Norway Pine, especially Relating to Sills of Freight Cars. The paper contained numerous drawings, diagrams, statistics, etc. It was briefly discussed by Messrs. Hickey, Brown, Rhodes, Verbryck and Shroyer.

The subject of Standard Axle for 60,000 pound Cars was briefly discussed by Messrs. Barr, Shroyer, Swanson and Forsyth.

It was resolved that a committee of three be appointed to recommend the proper sizes of car axle for a 50,000 and a 60,-000-pound car, and at the same time to express its recommendation whether they should adopt a collarless axle or not; also to determine whether they can maintain the original length between centers of journals according to the old M. C. B. standard.

The Chairman appointed as members of this Committee Messrs. Verbryck, Shroyer and Hickey.

New York Railroad Club.

THE regular monthly meeting was held in New York, November 17. The discussion of the question of Heating and Lighting Passenger Cars was continued.

New England Railroad Club.

THE regular monthly meeting was held at the rooms in the Boston & Albany Station, Boston, November 9.

An invitation to attend the tests of the Westinghouse freight brake was received.

It was resolved to appoint a committee to co-operate with the one already appointed by the Western Railway Club in selecting some uniform coupling for use between cars equipped for heating by steam from the locomotive. The President appointed F. D. Adams, J. W. Marden and Albert Griggs as this committee.

The discussion of the subject for the evening—Axles, Journal Bearings and Lubrication—was then opened by Mr. Marden, who urged the use of a larger journal and better material for axles.

President Lauder described the Johann journal-box and advocated its use. He also advocated larger journals.

The discussion was continued by Messrs. Adams, Howard, Shinn and others.

The subject for discussion at the December meeting is Continuous Brakes for Freight Trains.

Boston Society of Civil Engineers.

A REGULAR meeting was held at the rooms in the Boston & Albany Railroad Station, Boston, November 16, 59 members and 25 visitors present.

The Committee on Weights and Measures reported on the communication from the Western Association of Architects asking a concert of action in petitioning Congress to adopt the metric system in all departments of the government for all public business, and recommended that a canvass of the Society be made to ascertain the opinion of the members upon the matter. The recommendation was adopted. The usual appropriations were made for renewing subscription to the Society's periodicals and for binding.

Mr. A. V. Abbott, Chief Engineer of the National Superheated Water Company of New York, gave a very full description of the plant now being built by the Boston Heating Company. A full-sized section of the main pipes used, together with the expansion joint, house connections and other parts of the system, were exhibited and fully explained.

Connecticut Association of Engineers and Surveyors.

THE fall meeting was held in Hartford, Conn., November 9. The members inspected the new work at the Asylum Street crossing and other engineering work in progress in and near the city.

Mr. C. E. Chandler read a paper on the Rental Value of Hydrant Service, which was discussed by the members present.

The annual meeting of the Association will be held January 10 next.

Engineers' Club of Philadelphia.

A REGULAR meeting was held at the Club's House in Philadelphia, October 15, Past President Frederic Graff in the chair; 20 members and 1 visitor present.

Mr. A. Marichal presented a description of the Gileppe Dam, Belgium, illustrated by photograph and drawings, and followed by a discussion having for its object to prove that a saving of 50 per cent. of masonry could have been effected, together with an increase of stability, by adopting a profile taken from his Diagram for the Construction of Reservoir Walls, presented to the Club on May 21, 1887.

Mr. A. Saunders Morris presented notes upon Connections for Secondary Batteries.

Arrangements for connecting the elements of storage batteries have given some trouble, principally on account of oxidation. The best form of connection is one in which the joint is removed as far as possible from the acid, and which can be readily detached for the purpose of removing the element.

Several forms of binding posts or connections were exhibited, made of tough lead alloy. Both male and female threads are cast, so that the castings are turned out of the molds, completely finished, at the rate of one per minute. The mold for casting the screws was also exhibited.

The Secretary presented, for Mr. W. H. Nauman, a description of Tests for Riveted Joints made at Watertown Arsenal, Massachussetts, for the Bureau of Steam Engineering, September, 1886, accompanied by very complete drawings and tables.

Mr. Henry Roeske, of Philadelphia, introduced by the Secretary, presented an illustrated description of a system of Water Filtration, devised by him. He preceded this description by a historical sketch of the filtration of water and the various principal devices which have been used for the purpose of accomplishing it. Mr. Roeske's filter consists of a series of compartments so arranged that a large excess of water can be used for agitating and cleansing the filtering material in each compartment separately, while the rest of the compartments are furnishing a continuous supply of filtered water. The material in each compartment is designed to be cleansed at intervals of hours or days, as may be desired, by the action of automatic valves, which are operated by a lever, formed of pipe which fills with water at the designed intervals, and by its thus increased weight operates the valve. Sand and coke are the materials used. They are placed in separate compartments, the design being to protect the coke from the coarser impurities, so as to lengthen the time of its use. It is intended that the coke be used, also, as fuel after removal from the filter.

A REGULAR meeting was held November 5, President T. M. Cleemann in the Chair; 17 members present.

The Tellers reported the following elected active members: Henry I. Snell, Henry B. Seaman, Frank Cooper, Arthur H. Wood, Erwin Graves, I. H. Wainwright and Fred J. Amweg.

The Secretary called attention to the fact that December 17 of this year would be the tenth anniversary of the organization of the Club, and recommended that it be observed by the holding of a reception in the Club House on that evening. After some discussion the following resolution, was unanimously adopted:

"*Resolved*, That a Committee, with power to act, be appointed to take charge of a Decennial Anniversary Reception, to be held in Club House on December 17, 1887, at 8 o'clock, P. M.; said Committee to consist of as many members as Chair may decide, who shall issue cards of invitation, given on request of members, the latter to be entitled to invite not exceeding three members of the engineering or architectural professions, all members being requested to subscribe $2 by notice sent by the Secretary, and that such other invitations may be issued as the Committee shall deem proper and desirable."

The President appointed as the Committee: Percival

Roberts, Jr., Chairman: E. V. d'Invilliers, L. M. Haupt, C. G. Darrach and Frederic Graff.

Mr. C. G. Darrach presented a paper on Boiler Specifications, which was discussed at length by Messrs. John T. Boyd, Chas. T. Thompson, A. Marichal, J. E. Codman and others. At a late hour Mr. Codman moved that the discussion be continued, and that such copies of the specifications as the author could supply be sent to such members as would probably take part in the discussion, which was adopted.

Engineers' Club of Kansas City.

A REGULAR meeting was held at the rooms in Kansas City, Mo., November 7. Mr. Wynkoop Kiersted was elected a member.

The Secretary read a letter from the Executive Board of the Council of Engineering Societies, inviting co-operation. It was voted that the President appoint a Committee of three to act in conjunction with the other Committees of the Council. The President appointed Messrs. Chanute, Breithaupt and Wise.

Mr. Wynkoop Kiersted read a paper on Water Supply and its Development for Small Cities in the West, which was then discussed.

Engineers' Club of Minneapolis.

AT the last meeting of the Club, Horace E. Horton, of Rochester, Minn., was elected a member. Mr. James Rigby read a paper on Gas and Light. He showed how vast had been the progress in artificial lighting, and yet how little understood the subject is at present. He had with him some interesting drawings.

The Club will hold meetings semi-monthly during the winter.

American Institute of Architects.

THE 21st annual convention was held in Chicago, October 19, and continued for three days. The business of the convention was disposed of, and papers were read by Messrs. D. Adler, M. G. Bell, W. W. Boyington, D. H. Burnham, J. C. Cady, C. H. Harn, John Moser, J. L. Smithmeyer, J. M. Wilson and others.

The following officers were elected for the ensuing year: President, R. M. Hunt, New York; Secretary, William A. Potter, New York; Treasurer, O. P. Hatfield, New York. Board of Trustees, N. Le Brun, New York; L. T. Scofield, Cleveland; H. M. Congdon, New York; John W. Root, Chicago. Committee on Education, Professor N. Clifford Ricker, Urbana, Ill.; Alfred Stone, Providence; Professor W. R. Ware, New York; J. W. McLaughlin, Cincinnati; Henry Van Brunt, Boston. Committee on Publication, Charles Crapsey, Cincinnati; T. M. Clark, Boston; S. S. Beman, Chicago; George C. Mason, Jr., Newport. Secretary for Foreign Correspondence, Arthur Rotch, Boston.

American Society of Mechanical Engineers.

THE annual meeting of this Society was to be held in Philadelphia, November 28, continuing until December 2. The programme includes opening session and annual address by the President, November 28; business meeting November 29; sessions for reading of papers and discussion, November 29 and 30; excursion to Bethlehem, December 1. Invitations have been received to visit industrial establishments at Bethlehem; also a large number in Philadelphia. A reception at the Academy of Fine Arts was to be held on the evening of November 30.

The following papers are to be presented and discussed at this meeting.

Lewis F. Lyne: The Use of Kerosene Oil in Steam Boilers.

Henry I. Snell: Method of Ventilating and Heating Office and Warehouse.

John E. Sweet: A New Principle in Piston Packing.

R. H. Thurston: Internal Friction of Non-Condensing Engines.

John J. Grant: The Milling Machine as a Substitute for the Planer.

Henry I. Snell: Centrifugal Fan Blowers and the Power to drive them.

John Coffin: Steel Car Axles.

Oberlin Smith: Power Press Problems.

Frank Van Vleck: Standard Section Lining.

Percy A. Sanguinetti: Divergencies in Flange Diameters in Pumps, etc.

Wm. O. Webber: Centrifugal Pump Efficiencies.

Gaetano Lanza: Friction of Toothed Gearing.

Jerome Sondericker: How to Test Strength of Cements.

H. deB. Parsons: Influence of Sugar upon Cements.

James M. Dodge: New Method of Stocking and Reloading Coal.

E. C. Felton: Results obtained from Steel Tested shortly after Rolling.

O. C. Woolson: Road-bed for Railroad Bridge Structures.

The following subjects and queries for topical discussions were also to be presented at this meeting:

50. What is the best form of pump to use with driven wells, where lift is 10 to 20 ft., and air is likely to get into the suction. Should the pump be single or duplex, and with piston or plunger?

51. Have you used driven wells successfully; of what sizes and depths, and singly or in groups?

52. Are roller-bushings expedient in journals at low velocities and under high pressures?

53. What is the best material for lining brake-straps on elevators, cranes, etc.?

54. What is the best way to secure tight fit of set-screws tapped into heavy parts of a machine?

55. How much should be removed from the edges of punched or sheared steel plate to cut away the injured metal?

56. Have you used power molding-machines successfully in the foundry.

57. What makes the best molds for complicated steel castings to secure solidity and freedom from shrinkage cracks?

58. What is the effect of adding small per cents. of wrought-iron or steel scrap in the foundry cupola or ladle?

59. What kinds of pig-iron give the best results in light castings, where easy tool-treatment is the essential rather than strength?

Brotherhood of Locomotive Engineers.

AT the annual convention in Chicago, October 26, the opening address of Grand Chief Engineer P. M. Arthur presented the following facts concerning the Brotherhood:

"A mighty army of men, representing 365 divisions, has gathered about a nucleus of 12 men, who, 24 years ago, assembled in the City of Detroit and started an organization destined to be more than they knew or dreamed.

"To-day we number 25,000 men, and, while our numbers are great, we would not have you consider only the quantity, but the quality as well. To be a Brotherhood man, four things are required, namely, sobriety, truth, justice and morality. This is our motto, and upon this precept have we based our practice. At last year's convention we deemed it best to slightly change our plan of insurance, so as to bring it within the reach of all. We now claim to have at once the cheapest and the best, the most satisfactory, insurance in existence. We have paid out during the fiscal year just closed, to widows and orphans, $259,500, making a total of $2,244,669 that we have paid since the organization was established in December, 1867.

"At the close of the last fiscal year we had 4,444 members. Died during the year, 77; disabled, 11; forfeited, 183; and had on September 1 last 6,287, showing a net gain of 1,843. Our *Journal's* circulation has now reached 22,000, from which we derive a revenue of $8,922 per year. During the year our Chief Executive has traveled over 50,000 miles of territory, adjusting grievances and attending union meetings.

"Taking all things into consideration, our relations—both to ourselves and with various railroads employing Brotherhood men—are amicable. When we consider the dissatisfaction which is everywhere manifested about us (almost can we feel it in the air which surrounds us) our few troubles pale into insignificance."

Master Mechanics' Association.

THE following committee circulars have been issued by the Secretary, Angus Sinclair, from his office, No. 175 Dearborn Street, Chicago:

TRACTION-INCREASERS IN CONNECTION WITH OVER-CYLINDERED ENGINES.

Can the defect of an over-cylindered engine be best remedied—

(*a*) By the application of a traction-increaser; or

(*b*) Would you in preference recommend that the cylinders

be lined with a steel bush (a practice common in marine service); or

(*c*) That additional dead weight be judiciously distributed all over the driving wheels; or

(*d*) That a lower boiler pressure be used with an altered ratio of steam expansion?

2. If you approve of the use of traction-increasers on the standard American engine, would you also recommend their application to Mogul, Consolidation and Decapod engines? If not, why would you restrict their use to four-wheel-coupled engines?

3. Having equipped an engine with traction-increaser, would you dispense with sand and sand-box?

4. (*a*) In your opinion does a traction-increaser practically lengthen the engine wheel-base, thereby increasing the locomotive resistance on curves?

(*b*) Can you quote an experiment showing the difference in haulage capacity of an engine so equipped—first on tangent and then on curve?

(*c*) If you have an engine equipped, will you try this experiment, and communicate the results?

5. If traction-increasers are of acknowledged use in case of emergency, is there any reason why they should not be used continuously, and thus utilize, each trip, the advantage of the increased haulage capacity (this being the service for which patentees claim that traction-increasers were designed)?

6. If they are useful at low speeds, is there any reason why they cannot be made just as useful at high speeds?

7. (*a*) Are you familiar with any schemes for increasing traction other than those known as Dees, Purves, Craven (automatic traction draw-bar), and the Locomotive Improvement Company's?

(*b*) Would not the simple application of screw and lever (as used in European practice to increase the weight on a single driving-axle), accomplish the desired end as effectively as the above-mentioned designs?

8. Have engines regularly using traction-increasers developed any special failures in springs, spring gear, side rods, cylinders, loose tire or special wear on tires, or in cracks in frame, horns and horn-stays?

9. Give any information possible as to first cost, cost of application and cost of repairs to traction-increaser, also additional outlay or estimated saving in the cost of general repairs of engines fitted with a traction-increaser.

This Committee would like to have their report in the hands of the Executive not later than the last day of April, 1888.

J. Davis Barnett,
F. L. Wanklyn, } Committee.
T. J. Hatswell,

Replies should be addresssd to J. Davis Barnett, Mechanical Superintendent, Grand Trunk Railway, Port Hope, Ontario.

EXTENSION SMOKE-BOXES AND FIRE-BOX ARCHES.

It is a recognized fact that the railroad interest of this country is passing through a crisis unequaled in its history, and it is plain that it becomes the duty of all interested to aid in its safe passage. The fuel consumed by locomotives, together with the expense of adjusting fire claims caused by fire thrown from locomotive stacks, are two of the larger items of expense connected with railroad operations.

Extension Smoke-boxes and Brick and other Fire-box Arches is a subject bearing directly on the above points, and it is asked as a duty of each and every member of the Association, and of all having charge of railroad machinery, to assist the Committee in getting out an intelligent and reliable report by answering as clearly and fully as possible the following questions:

1. What kind of fuel is used on your locomotives; hard coal, soft coal or wood?

2. What is the average amount of water evaporated per pound of the coal you are using?

3. What is your average cost per locomotive-mile for fuel?

4. What form of smoke-box is used on your locomotives?

5. Have you had any experience with the so-called "extension fronts"? If so, please give dimensions of the same, with sketch showing location and kind of netting, and situation of deflector plate, if any used, also situation of exhaust nozzles and arrangement for discharging sparks.

6. What form of smoke-stack do you use in connection with the extended front? In the same connection, please state size of engine cylinders, size of nozzles, dimensions of fire-box and number of flues.

7. Do you advocate the use of single nozzle in connection with the extended front?

8. Have you had any experience with a device in the ordinary box that would accomplish the same end as that claimed for the extended front? If so, please state results obtained and send drawings of the same, and state if, in connection, any extras are used in fire-box as well as showing smoke-stack construction.

9. Do you favor the use of a draft or petticoat pipe in connection with the extended front?

10. What is the amount of additional weight caused by extended front and attachments?

11. How do you regard the old style smoke-box and diamond stack in economy of maintenence, economy of fuel and preventative of fires as compared with the extension fronts and attachments?

12. Have you used a fire-brick arch or other device in fire-box in connection with extended front? If so, please give dimensions of same, with sketch showing the device and manner of sustaining it, and the results obtained as compared with the plain fire-box in the same connection.

13. Do you favor the use of a brick or other arch in the fire-box of a locomotive using bituminous coal, and can you say from experience that the advantage gained thereby will warrant the expense of maintaining such arch?

14. Have you noticed any injuries to fire-box sheets resulting from the use of a fire-box arch? Please send drawing of the fire-box grates used in connection with your extended front.

15. Under what circumstances, if any, do you advocate the use of hollow stay-bolts in fire-box for the purpose of admitting air above the fire?

16. All things considered, do you favor extended fronts on locomotives as now generally constructed? If not, please state objections.

Please do not confine yourself to the questions asked, but, with your advice and aid of drawings, give the Committee any information you may possess bearing on the subject.

John Hickey,
W. A. Foster, } Committee.
E. L. Weisgerber,

Answers should sent to John Hickey, Master Mechanic, Wilwaukee, Lake Shore & Western Railroad, Kaukauna, Wisconsin.

Master Car-Builders' Association.

The following circular has been issued from the Secretary's office, dated November 15:

"The report of the Executive Committee of the Master Car-Builders' Association having been approved by the Association, and the Janney Type of Coupler having been made the Master Car-Builders' Standard, a sub-committee has been appointed by the Executive Committee to consummate the recommendation of the report that the Association procure one of the present makes of Janney Type of Coupler, selection being made by a committee appointed for that purpose, and then all other forms of couplers that will couple to and with this coupler, under all conditions of service, are to be considered as within the Janney Type and conforming to the standard of this Association.

"All parties who claim to manufacture couplers within the Master Car-Builders' Type are requested to send two couplers, completely finished and ready for service, to R. D. Wade, Superintendent of Motive Power, Richmond & Danville Railroad, 1300 Pennsylvania Avenue, Washington, D. C., on or before December 13, 1887. Such parties are further requested to send a representative, to appear before the Committee on the above date and at the above place, who will with proper drawings describe the mechanical construction of the coupler he represents, such drawings to remain with the Committee and become the permanent property of the Master Car-Builders' Association.

"If in the judgment of the Committee it should become necessary to attach the couplers to cars, the Committee will provide cars and facilities for testing, but all expenses incident to attaching the couplers must be defrayed by the owners of the couplers.

"The Committee will not consider models or drawings of couplers not represented by full-sized couplers ready for attachment to cars as above described.

"The Committee will make their report to the Executive Committee, who will issue drawings of the Master Car-Builders' Type, and officially announce the names of the couplers which are within this type.

"The members of the Master Car-Builders' Association are invited to meet with the Committee and assist them in their investigation of the various couplers.

"Edward B. Wall,
"R. D. Wade, } "Committee."
"John S. Lentz,
"J. W. Cloud,

PERSONALS.

Mr. P. A. Smith is now Resident Engineer on the Texas & Pacific road.

Mr. C. E. Marvin has been appointed Roadmaster of the Central Railroad of Georgia.

Mr. R. C. Peebles has resigned his position as Superintendent of the Mexican National Railway.

Mr. H. Tandy has been appointed Superintendent of Motive Power of the New York, Ontario & Western Railroad.

Mr. J. D. Letcher is Chief Engineer of the Ohio & Northwestern road, with headquarters at Portsmouth, Ohio.

Mr. C. H. Mead has been appointed Master Car-Builder of the Texas & Pacific road, with office at Marshall, Texas.

Mr. E. Canfield, late Division Superintendent, is now Chief Engineer of the New York, Ontario & Western Railroad.

Mr. F. L. Stevens has been appointed Chief Engineer of the Main Line Division of the Philadelphia & Reading Railroad.

Mr. Edmund Yardley is now Superintendent of Transportation of the Pennsylvania Company's lines, with office in Pittsburgh.

Mr. Joseph Wood has been appointed General Superintendent of Transportation for all the Pennsylvania lines west ot Pittsburgh.

Mr. George L. Potter is Master Mechanic of the Pennsylvania Company's shops at Fort Wayne, Ind., succeeding F. D. Casanave, promoted.

Mr. J. T. Dodge has resigned his position as Chief Engineer of the Montana Central Railroad. His present address is Duluth, Minnesota.

Mr. C. W. Lanpher, late Division Superintendent, is appointed Superintendent of Transportation of the New York, Ontario & Western Railroad.

Ex-Governor Benjamin F. Prescott has been appointed Railroad Commissioner of New Hampshire, succeeding E. J. Tenney, whose term has expired.

Mr. Benjamin Thomas, lately on the New York, Lake Erie & Western, is now General Superintendent of the Chicago & Atlantic road, with office in Chicago.

Mr. F. D. Casanave has been appointed Superintendent of Motive Power of the Pennsylvania Company's lines (west of Pittsburgh) and will have his office at Fort Wayne, Indiana.

Mr. Theodore Scheffler, of Paterson, N. J., is now in Germany, introducing the Rotary Steam Snow-shovel on the Saxon State railroads. The order for the first or sample plow has been given; it will be built in Saxony.

Mr. A. Gottlieb has taken an interest in the Mt. Vernon Bridge Company at Mt. Vernon, O., and will act as Consulting Engineer. He will also retain his connection with firm of A. Gottlieb & Co., and his office in Chicago.

Mr. Michael Rickard, of Utica, has been appointed a Railroad Commissioner of New York to succeed John D. Kernan, resigned. Mr. Rickard is a locomotive engineer on the New York Central road. He was nominated for the office last winter, but not confirmed.

Mr. A. K. Mansfield, Mechanical Engineer, has removed his office from Chicago to New York, and has established himself there at No. 280 Broadway (Stewart Building) in company with Mr. George L. Mansfield, under the firm name of A. K. Mansfield & Company.

Mr. John Bogart was elected State Engineer of New York on November 8. The State thereby gains a most capable and efficient public officer; it is to be hoped that the American Society of Civil Engineers will not lose the services of an excellent Secretary.

Mr. James McCrea, late Manager, has been made Fourth Vice-President and General Manager of the Pennsylvania Company, the Pittsburgh, Cincinnati & St. Louis Railway Company and the Chicago, St. Louis & Pittsburgh Railroad Company. His office will be in Pittsburgh.

D. J. Whittemore, of Milwaukee; **Joseph M. Wilson**, of Philadelphia, and **Alfred P. Boller**, of New York, form a committee of engineers selected to report on the long-discussed question of providing proper terminal facilities in Providence, R. I., for the railroads entering that city.

NOTES AND NEWS.

An English Electric Yacht.—The new yacht *Countess*, which is claimed to be the largest vessel to which electric propulsion has yet been applied, has had several successful trials near London. The boat is 90 ft. long and has a screw 3 ft. 6 in. diameter and 5 ft. 6 in. pitch, which is to run 200 revolutions a minute. The motor is of the Elieson pattern.

French Iron Production.—The total production of pig-iron in France in 1886 was 1,507,850 tons. The production of manufactured iron was 767,214 tons and of steel 466,913 tons. There was a slight decrease in each item. The steel production included 348,299 tons of Bessemer and 89,755 tons of open-hearth steel.

During the year there were 20,014,597 tons of coal mined in France; 8,366,205 tons of coal and 1,059,282 tons of coke were imported.

English Consumption of Iron Ore.—The amount of iron ore used in Great Britain last year is given by official returns as follows, in tons:

	1886.	1885.
Mined in Great Britain	14,110,013	15,418,082
Imported from other countries	2,878,469	2,822,598
Total	16,988,482	18,240,680

Nearly all the imported ore—2,646,089 tons—came from Spain. Algeria supplied 165,554 tons, and only insignificant amounts came from other countries.

Signals at Sea.—The New York Maritime Exchange has prepared a memorial to the President, requesting him to take measures to bring about an international conference for the purpose of arranging an improved system of signals to be used by ships at sea, the system now in use being considered crude and imperfect.

Should such a conference be called, it is suggested that several other subjects might be considered, among them the concerted use of naval vessels of all nations in securing improved charts, etc., life-saving service, and the removal of derelict wrecks at sea.

The Military Prize Essay.—Lieutenant E. R. Hills, Assistant Secretary of the United States Military Service Institution, has issued the following notice:

"At a meeting of the Executive Council of the Military Service Institution, held on Governor's Island, October 20, the following was selected as the subject for the prize essay of 1887: 'Organization and Training of a National Reserve for Military Service.'

"The object is to open for discussion the general question of how a national reserve force available should be organized and how it should be trained by annual manœuvres or otherwise, for immediate service."

Train Lighting Extraordinary.—We have seldom seen a more remarkable or original notion put forward in a responsible quarter than that contained in a French specification filed by *La Société pour le transport de la force par l'Electricité*, as a method of lighting railway carriages by electricity. This is the company of which M. Marcel Deprez forms so distinguished an ornament. The proposal is to place a small windmill upon the roof of each carriage, and so to provide motive power for the usual paraphernalia of dynamos, secondary batteries and glow-lamps. As to the prospects of success of this scheme, while, of course, we shall hope for the best, yet we are prepared—we may say *fully* prepared—for the worst.—*London Electrician.*

A Palace Street-Car.—The Gilbert Car Manufacturing Company has nearly completed a street car for Dom Pedro of Brazil, which is to be the most expensive car of that description ever built. The body of the car is of paneled mahogany inside and out, and all metal work showing is gold plated. The car is about the size of an ordinary street car and has four windows on each side, the glass being very heavy French plate. The windows have curtains of brocatel inlaid with cloth-of-gold. The roof is surmounted by a dome which is of jeweled glass, furnished by Tiffany, of New York. The furniture of the inside consists of two divans upholstered with cloth-of-gold, and four large arm-chairs of rattan gilt, and provided with curtains of silk plush. The wooden panels inside are covered handsomely, the crown of Brazil being a prominent feature. The floor is covered with the finest Wilton carpet, and all the accessories are of the finest kind, even the water-cooler being gold-plated. This car is probably the finest specimen of work of the kind ever turned out.

Finding a Lost Car.—A very singular loss and recovery occurred recently on the Union Pacific near Laramie. A special freight, running psseanger time, broke in two on the

hill, and the front section ran around a sharp curve so fast that it whipped off the rear car, filled with choice Chinese silks, into the gulch, where it disappeared from sight in the heavy brush. The break was so clean that the two sections were coupled without the single car's absence being noticed. For two months that car lay there, while the entire road was being searched far and near for it. The other day a cowbow rode into a small station on the line and casually asked when they were going to clear up that wreck down in the gulch. The agent knew of no wreck, and thought the cowboy was fooling with him, but at last, convinced he was in earnest, went with him to the spot. There, at the bottom of a very deep fill, behind a huge pile of boulders and a mass of sage brush, lay the missing car, No. 99. It was resting on its side, and strange enough, the trucks were in proper place. The doors were sealed, and there was nothing beyond a few bruises and dents in the roof and sides to show that there had been any rough treatment experienced.—*Omaha Republican.*

Blast Furnaces of the United States.—The tables compiled by the *Iron Age* give the condition of the blast furnaces on November 1 as follows:

Fuel.	In blast. Furnaces.	In blast. Weekly capacity.	Out of blast. Furnaces.	Out of blast. Weekly capacity.
Charcoal	70	12,344	103	8,864
Anthracite	124	40,028	74	17,111
Bituminous and coke	151	90,459	56	17,901
Total	345	142,831	233	43,876

The *Iron Age* comments as follows: "On the whole, October has been rather an uneventful month for the pig-iron industry of the United States, so far as fluctuations in the capacity actively at work are concerned. There has been very slight falling off in anthracite pig production, and a slight gain in coke iron, the aggregate make being very heavy. So far as reports bearing on the immediate future are concerned, they do not indicate any decided movement, either in the direction of a restriction or of an expansion. Indeed, it may be said that the current production is very close to the maximum capacity, considering the slight inducements which are offered by present prices as related to costs."

Beton Forts.—It is known that the new fortifications at Antwerp have been built on new plans, adopted for the purpose of meeting the progress of modern artillery, and especially to provide against the use of the improved projectiles.

The explosion of shells of the latest patterns is very destructive to masonry walls, as was shown at Cummersdorf and the fort of Malmaison. Accordingly engineers have been led to substitute beton or concrete for brick or stone masonry in those parts of a fortification which are exposed to the fire of siege guns.

At the fort of Schooten, which is part of the advanced line of defense at Antwerp, all the casemates are of beton. These casemates are 3 meters in thickness at the crown of the arch, and it is believed that they will be strong enough to withstand the effect of any fire.

It may be noted that the extreme precision and the long range of modern siege guns have made it necessary to abandon almost entirely the defense of forts by guns *en barbette* or in the open air. For this reason all the heavy guns are now covered or placed in casemate, and for defense against assault smaller rapid-firing guns and machine-guns or mitrailleuses are provided.—*Revue Scientifique.*

Car Service Charges.—The Pennsylvania Railroad Company has made the change in charges for freight-car service which was recommended by the Car Accountants' Association, substituting a mixed mileage and per diem charge for the simple mileage charge (¾ cent per mile) heretofore made. The new system took effect October 1, and its details are given in the following order:

"1. The mileage rate shall be ½ cent. per mile and 15 cents per day per car for each day, Sunday included.

"2. The rate on four-wheel cars shall be ¼ cent per mile and 7½ cents per day.

"3. No per diem charge to be paid on cars delivered and returned the same day.

"4. Days to be counted from one day to another, that is, a car received on April 1 and delivered on April 5 equals 4 days.

"5. The per diem charge on cars shifted by one railroad for another, for the purpose of receiving or discharging lading, shall be paid by the road on which the switching is done.

"6. The per diem rate shall be paid on cars in shops, and on cars destroyed, until date of notice to owners."

Other prominent companies have signified their intention of adopting the same system, which will probably come into general use.

Excavation by Dynamite.—*Le Genie Civil* gives an interesting account of the use of dynamite for sinking holes in wet ground for foundations. It has been successfully used in building the fortifications around the City of Lyons. The foundations for the walls were to be built in an alluvial soil, constantly inundated by the River Rhone, and composed of shifting sand. It was necessary to sink two meters to find good ground on which to build. Eight cartridges of dynamite, containing each 100 grammes, were exploded together, resulting in a hole 1.10 meters diameter. In this a metal cylinder was sunk, the hole then cleared out, the concrete filled in, and the cylinder withdrawn.

Three points are especially interesting in this matter.

1. The explosion makes a hole shaped like the frustum of a cone, 1.00 to 1.20 meters in diameter, with a depth equal to 75 per cent. of that required, on account of the earth falling in.

2. The explosion compresses the surrounding earth to such a degree that the walls of the hole remain vertical long enough to clean out the hole and put in the concrete.

3. The water is driven back so far that it does not begin to again filter through the walls for half an hour.

This operation was so expeditious that in a single day of 10 hours 5 holes 2 meters deep were sunk, cleaned out and concreted, and the work of laying foundations on them was begun. The foundation was 24 meters long.

A Russian War-ship.—A new Russian ironclad, modeled on the *Impérieuse* of the English Navy, has just arrived at Cronstadt from the Baltic Engineering Works at St. Petersburg, to receive her artillery, etc., aboard, preparatory to being attached to the Baltic fleet. The *Admiral Nakhimoff* is 333 ft. long (the *Impérieuse* is 315 ft.), 61 ft. broad (the *Impérieuse* is 62 ft.), and has a displacement of 7,782 tons as compared with the 7,390 tons of the English vessel. The contract for the ironclad was signed in July, 1884, and the launch took place in October the following year. Last October the official trials took place, when the engines (two triple-expansion engines of 4,000 I. H. P. each) worked up to 4,500 H. P. and realized a speed of 17½ knots. The hull of the *Nakhimoff* is built entirely of Russian metal, the steel being manufactured at the Putiloff Works at St. Petersburg. The armor-plating, which ranges in thickness from 6 in. to 10 in., was rolled at the Kolpina Steel Works, where Messrs. Cammell & Co. have established an armor rolling-mill for the Russian Government. Without armor and fittings the hull has cost $1,310,000; the engines, without auxiliary mechanism, $640,000. The pumps are of the Gwynne description, and the fire engines are being supplied by Messrs. Shand & Mason. The two torpedo cutters, which the ironclad carries, have been built by Messrs. Crichton & Co., of Abo, Finland. The machine guns used are of the Hotchkiss description, and the vessel is fitted with a tube for discharging 15-ft. Whitehead torpedoes. In general, the Russians are very pleased with the new addition to the Baltic fleet, and claim that during its construction advantage has been taken to rectify the defects which practice has brought to light in connection with the *Impérieuse.*—*Engineering.*

The Manchester Ship Canal.—At the recent meeting of the British Institute, Mr. E. Leader Williams, Engineer of the Manchester Ship Canal, read a paper on the canal. At the outset he mentioned that, after unsuccessful attempts in the years 1883 and 1884, acts of Parliament were obtained in the sessions of 1885, 1886 and 1887, which gave the Manchester Ship Canal Company power to construct a large ship canal from the deep water at Eastham, near Liverpool, to Manchester. The Board of Trade having certified that the conditions in the Acts relating to capital had been complied with, the contract for the whole of the works had been let to Mr. T. A. Walker, of Westminster, and the construction of the canal would be commenced as soon as the arrangements, now in progress, for the purchase of the lands required were completed. The canal would be of greater bottom width than the Suez, Amsterdam or any other ship canal, and it would absorb the whole of the waters of the rivers Mersey and Irwell, and their tributaries, between Manchester and Warrington. From Eastham to Warrington, a distance of 20 miles, the tidal water of the Mersey estuary would be impounded on one level by large entrance locks at Eastham. The depth of the water in the canal would vary with the height of the tide, but would never be less than 25 ft. The minimum bottom width of the canal would be 120 ft., or nearly 45 ft. more than the Suez Canal. Above Warrington, large ship locks would be constructed at Latchford, Irlam and Barton, to raise the canal to the level of Manchester. The total length of the canal would be 35½ miles. Docks, quays and basins would be constructed at Manchester, Barton, Warrington, Partington and Weston Point. The existing docks at Runcorn, now the pro-

perty of the Manchester Ship Canal Company, were connected with the canal and would afford the means of developing the trade of Staffordshire and the Potteries. The docks at Weston Point and Ellesmere Port were on the canal. The Bridgewater canals recently purchased by the Ship Canal Company were in connection with the proposed new docks at Manchester, and all the inland canals were in direct communication with the Bridgewater Canal, which would also join the Ship Canal at Runcorn and Barton.

Antarctic Exploration.—The endeavors of the Australian colonies to raise money for resuming explorations in the Antarctic regions have so far been unsuccessful. The funds for rewards to whalers extending their cruises beyond the 60th degree of south latitude have not been appropriated, and nothing has been done since Allen Young's offer to take command of an expedition of this kind. Sir Graham Berry has, in accordance with instructions from the Government of Victoria, asked the British Government to contribute the sum of £5,000 toward an Antarctic expedition, provided the Australian colonies agree to contribute an equal sum, and the subject is now under consideration. The financial state of the colonies is not very good at the present time, and therefore it is not likely that any energetic attempt will be made. The movement for resuming these explorations originated in Germany; but so far nothing has been done there to raise money and send out an expedition, as the activity of explorers is almost exclusively directed toward Africa and the islands of the Pacific Ocean.

Our American whalers are those who have the most immediate interest in the matter, as they frequent the neighboring seas and obtain considerable quantities of whale-oil from that region. A few years ago one of them landed on Graham Land and found near its shores an abundance of sea-animals; but as he had no authority to visit those dangerous latitudes, and as the ice was closing upon his ship, he did not continue his explorations. We do not think that the endeavors of the Australian colonies will be successful for some time to come, and it would be gratifying if, meanwhile, American enterprise would take up this important problem, in which no nation is more interested than we are, as our vessels are those which visit Antarctic waters most frequently, and as a successful approach is most probable close to the south point of our continent.

Arctic navigation shows that progress is always most promising under the shelter of land. Graham Land can be reached with comparative ease; and under its shelter, that is, on its eastern coast, important discoveries can be made without great risk and at no great expense. This would be a task for one of our whaling-masters who navigate year after year the ice-covered waters of the Arctic Ocean in their stanch and swift schooners.—*Science.*

Barge Building in Russia.—While Russia is not a builder of iron vessels for sea-going or, with rare exceptions, for river purposes, owing to the collapsed condition of the ship-building industries, she still turns out every year an immense number of wooden craft of considerable magnitude. If a steamer of 800 tons is a very large one for her to produce, and is only produced occasionally, she constructs every season wooden barges with the enormous cargo capacity of 8,000 tons for service on the Volga. Barges for canal purposes, as small as those used in this country, are scarcely ever seen in Russia. The average Russian barge conveys as much cargo as the average English coasting cargo ship. Plying regularly on the River Volga, season after season, are 3,000 permanent barges of 1,000 tons cargo capacity apiece, making a united cargo capacity of 3,000,000 tons. These are very strongly built, almost clumsily so, but answer the purpose for which they are intended—to carry cargoes to the Great Fair at Nijni Novgorod, and convey others back again to the various navigable branches of the River Volga. In excess of these, 200 barges are built on the Kama and Volga every year, intended only to carry goods to the destination and then be broken up, ranging in cargo capacity from 5,000 to 8,000 tons. Occasionally even barges of 10,000 tons cargo capacity are seen at the Great Fair. Such mammoth vessels are built in the autumn and winter, and float with the spring floods down rivers unnavigable in summer to the Volga, where they are taken in tow by steamers and conveyed to Nijni Novgorod. Their length—300 ft. or 400 ft.—unfitting them for traversing the canal system between the Volga and St. Petersburg—the locks accommodating only vessels 147 ft. long—1,000 smaller barges of 200 or 300 tons capacity are constructed specially for this purpose, being used afterward at St. Petersburg and other towns for firewood, etc. On the Volga also the barge builders turn out 4,000 ferry barges, fishing boats and small craft of various kinds every year. Formerly a large number of three-masted wooden vessels for the Caspian used to be built annually, but the rapid extension of the steamer service there has checked this branch of the industry. While in England canals have long been under a cloud in Russia the construction of railroad has very little agecied their traffic, and they are undergoing constant development.—*Engineering.*

A French Submarine Boat.—Vice Admiral Bourgeois is claimed in France as the first inventor of the submarine boat many years ago, and its prototypes, including the American *Peacemaker* essayed in other nations, are counted as but so many adaptations of the original idea. Dismissing any argument on the point, our present attention is engaged upon a diving vessel which is to be made at Toulon, and whose keel was laid as far back as April last on the slips of the Mourillon Docks. The lines of the new craft are due to M. Ramazotti, a first-class sub-engineer of the French Navy, and whose design is fast approaching completion. Shaped like a cigar, on the Winans type, the hull measures 55 ft. from end to end, and the widest beam is exactly 6 ft. The immersion of the vessel in controlled by means of leaden plates disposed along her sides, and when afloat only from 16 to 18 ft. of the crown of the shell will be visible above water. From the center of this part rises a small dome with bull's-eye ports around, and from the interior of the receptacle, the vessel is guided upon its course or made to sink or swim at the will of the commander within. The motive power is imparted by a Krebs electric motor of 50 H. P. which will work twin screws up to the estimated speed of 10 knots. The internal divisions of the hull and framework or fittings are of brass or red copper, and all the other machinery, excepting the screw actions, will be dependent upon compressed air from cylinders containing about 100 atmospheres in store. Room is also found within the shell for a considerable provision of respirable air for the crew, which includes the commander, 12 engineers and 3 seamen.

To sink the vessel to varying depths beneath the surface, water in requisite quantity is to be pumped into reservoirs, and to direct a straight course, an ordinary rudder in the usual position is employed, but to shape a vertical progress there are rudders hinged about one-third the length of the boat at the sides, aft, or just before the counters. With these adjuncts the rise or descent and oblique course of the hull are controlled, and in the supposition of a near approach, unobserved and scatheless, to a hostile vessel, the powers of destruction become available. The compressed-air tubes will enable the commander to launch two torpedoes of small size but terrific force from the diver. The two engines are linked together by a wire loop, and another wire connected with the battery in the boat pays out on their discharge. The diver withdraws from the spot, and, at a convenient moment, the explosion is effected with all safety of the assailants under water. It is stated that an automatic diving boat of similar nature has been successfully tried in Russia, during some operations on the Neva before the Czar.—*The Broad Arrow.*

Modern Sieges.—At the last meeting of the Military Service Institution on Governor's Island, N. Y., Captain J. G. D. Knight, U. S. Engineers, read a paper on the Attack and Defense of Modern Fortifications and the Latest Experience and Principles in Modern Sieges.

"The first point to settle is what can be considered modern sieges," began the lecturer, and then he briefly referred to Sebastopol, Strasburg, Metz and Plevna, and concluded that a modern siege was a siege conducted on both sides with all the methods of modern warfare.

The lecturer then called attention to the siege of Belfort, where all rules, except those relating to countermining and meeting assaults, were exemplified. He then touched upon the development of artillery; that of small arms; the relative effect of artillery and infantry fire, and the modifications of details and methods of fortifications. After this Captain Knight outlined the attack and defense of permanent works, and referred to the same points with respect to field works, touching especially on the use of modified sap work to be used in the attack of the latter.

"The attack and defense of field fortifications," continued the lecturer, "will always be of more importance to us than those of permanent works because of our foreign policy, of the sea-coast location of our permanent works, and, I might add, because of our probable line of operations toward our frontiers in case of war."

During the lecture Captain Knight also referred to the comparative range of ancient and modern firearms, and to the fact that while the modern breech-loader missed fire about 3 shots in a 1,000, the old smooth bore missed as many as 300 to 500, and even 800 in the case of the old flint-lock in wet weather. Captain Knight strongly advocated the use of plunging fire, which he claimed could be used with considerable effect upon defense, when the latter was stationed behind high

parapets and comparatively secure from the effect of direct fire. In this connection he drew illustrations from several instances of attack and defense which occurred during the Russo-Turkish war. The lecturer also impressed his hearers with the absolute necessity of strong supports, both in case of an attacking column, which might capture the enemy's first line of defense and find itself exposed to a murderous fire from the second line of defense, giving several illustrations as to how hard-earned advantages had been lost owing to the absence of such support, particularly referring to the check received by General Skobeleff at Gravsetzka.

In the case of attacking columns advancing on an enemy's earthworks, the lecturer drew attention to the fact that much depended upon the general in charge of the attack, who in order to effectively feel the pulse of the attack should be stationed, in spite of the great personal risk, midway between the extreme line of the attack and the reserve, so as to be able to correctly judge the right moment in which to call forward the reserves.

In all attacks, he said, there are the reckless, fearless men, who will rush forward and get killed; the men of moderate courage, who will stand fire for a considerable time, but eventually waver if subjected to severe loss, and lastly, the faint-hearted men, who are ever ready to turn tail to the enemy.

The order to bring the reserves into action, Captain Knight claimed, should be given while the second class of men, the men of moderate courage, were not demoralized, for to wait until they wavered would probably mean defeat.

A New Style of Torpedo-Boat.—The London *Times* says: "The defects of the old second-class torpedo-boats have long been recognized at the Admiralty, where also the desirability of combining in one vessel the speed and power of a torpedo-boat with the general usefulness of a pinnace has been felt. The vessel which was tried yesterday is known as Torpedo Boat No. 50 on the official list, and has been built by Messrs. Yarrow & Co., of Poplar. She is somewhat shorter than the old boats she is intended to supersede, but she has increased beam and freeboard. She is 60 ft. long with 8 ft. 6 in. beam, whereas the old boats are 63 ft. long with only 7 ft. 4 in. beam. The new boat, which has a lifting weight of 11¼ tons, is steel built throughout, with a flush deck, and has a mean draft of 2 ft. 3 in. The forward part is completely covered by a turtle-back designed to throw off the sea. Beneath this turtle-back is a small cabin in which about a dozen men can be accommodated. Aft of the cabin is a low conning tower where the steersman stands, and from which position the officer discharges the torpedo. The whole of the central portion of the boat is occupied, as usual, by the machinery. Aft of the stokehold and the engine room is another small cabin, which will accommodate a dozen more persons, and between it and the stern is the storeroom. The boat is propelled by triple-expansion engines driving a three-bladed screw propeller. The boilers are of the usual Yarrow type, with a copper fire-box and copper tubes. The furnaces are fitted with forced draft, and the working steam pressure is 150 lbs. per square inch. The boat is fitted with a partially balanced rudder. Her armament consists of a revolving torpedo gun which is carried aft and so arranged as to fire over either side of the vessel at any angle it may be desired to train it to. The object here in view is that the torpedo shall be discharged at any angle while the boat is going at full speed, instead of direct ahead as in the old system, which involves the boat being brought almost to a state of rest in the face of the enemy and under the fire of his machine guns. The difficulty of hitting a rapidly moving object compared with one at rest, as demonstrated by recent experiments, points to the importance of keeping the boat at full speed. She will also carry a Nordenfelt two-barrel gun, as used in the English service.

"An Admiralty trial of the new craft took place yesterday, the object being to carefully compare the present boat with the old boats. The trial was therefore made on exactly the same conditions as were formerly adopted, and consisted of a full-speed run of two hours' duration. The Admiralty was represented by Commander Egerton, Mr. Smale, and Mr. Shapcott, and the builders by Mr. Crohn. During the two hours' run six runs were made over the measured mile, three with and three against the tide, with the following results: First run, 14.815 knots; second run, 19.251 knots; third run, 15.126 knots; fourth run, 19.780 knots; fifth run, 14.634 knots; sixth run, 18.274 knots. This gives an average speed of 17.147 knots, which was obtained with a mean of 507 revolutions per minute, and this speed was maintained throughout the two hours' run. The average speed of the old second-class boats was 16.5 knots. It will, therefore, be seen that, notwithstanding that the new boat is heavier, shorter and broader than the old ones, there is actually an advance of speed of over half a knot. During the trial the manœuvring powers of the boat were tested, and were found to be much superior to those of previous second-class boats. She turned the circle in 40 seconds, the diameter being 35 yards. There was an entire absence of heel when turning. Another noticeable point was freedom from vibration. During the trial the machinery worked in every respect to the satisfaction of the authorities."

The Nicaragua Interoceanic Canal. — A Washington letter to the New York *Times* says: "The Nicaragua Canal Construction Company's expedition to survey the proposed canal route, which was to have sailed from New York on November 26, will not sail until the 30th. The engineer corps for the survey has just been completed. Civil Engineer A. G. Menocal, U. S. N. Chief Engineer of the Company, has made his selections with great care. The surveying corps will be divided into seven parties—five land surveying, one hydrographic, and one boring party. Civil Engineer R. E. Peary, U. S. N., will have immediate supervision of the work in Nicaragua. The *personnel* is as follows: Chiefs of Parties—J. Francis LeBaron, Jacksonville, Fla.; Domingo Garcia Cartaya, City of Mexico; Frank P. Davis, Washington; J. W. Pethard, St. Louis; Lieut. W. J. Maxwell, United States Navy; Peter Kolb Hoboken, N. J. First Assistant Engineers or Transitmen—W. V. Alford, Garrettsville, O.; S. G. Holcombe, Washington; F. T. Bernhard, New York; H. C. Miller, Louisville, Ky.; P. H. Bevier, New York; MacDonough Craven, Boston. Second Assistant Engineers or Levelers—Ricardo Molina, Havana, Cuba; J. S. Ford, New York; H. C. Litchfield, Jacksonville, Fla.; Calixto Guiteras, Philadelphia; A. J. Menocal, Washington; E. W. Hunt, Wisconsin. Rodmen—Emil Diebitsch, William McCawley and Perry Fuller, Washington; Enrique Cole, Managua, Nicaragua; Paul Spicer, Winchester, Mass.; Paul B. Cooke and P. V. R. Van Wyck. Chairmen—Louis William Mohuan, D. D. Stratton, John M. Murphy, R. J. Wilson, Henry W. Johnson, Washington; Daniel MacAuley, New York. Clerks—Jacob Crowninshield, New York, and Charles E. Kern, Washington. There will be a number of draftsmen and a medical staff of several experienced doctors.

"The engineers of the party have records that show that they have practiced their profession in many parts of the world, are experienced and well known. Mr. Peter Kolb, of Hoboken, N. J., a chief of party and graduate of the Technical University at Carlsruhe, Germany, has been engaged in various surveys and construction of railroads in Mexico, South America, and the United States. He was for some time employed on the Panama Canal, and had to resign his office on account of the unhealthfulness of the climate. His last work was on the Costa Rica Railroad extension to Carlazo. Frank P. Davis, of Washington, is a graduate of the University of Michigan and was for a short time employed in the War Department as a draftsman. He has been in charge of the location of railroads in Michigan, and for some time was Resident Engineer of the Denver & Rio Grande Railroad. Domingo Garcia Cartaya is a distinguished engineer of Mexico, and has figured prominently in the railroad enterprises of that country. J. Francis Le Baron, of Jacksonville, Fla., has been extensively engaged in engineering enterprises in Florida, having surveyed and estimated for a number of canals through the peninsula and other engineering projects. He is a member of the American Society of Civil Engineers, and Secretary of the Southern Society of Civil Engineers, and the author of standard articles on the "Archæology of Florida." H. C. Litchfield, of Jacksonville, Fla., is an Englishman, and served as a midshipman in the British Navy. He left the service, and, after being graduated as an engineer, accepted employment at Natal, South Africa, and later joined the Cape Colony Government railroad service. He remained in the Colony 10 years, and left the Government service and went to Buenos Ayres, Brazil, as Chief Engineer for the extension of the Buenos Ayres & Ensenada Railroad. Later he returned to England, and a year ago came to the United States, where he has been engaged in railroad work. F. T. Bernhard, late Assistant Engineer of the Standard Gaslight Company of New York, is a graduate of the University of Wisconsin, in which State he engaged in the State Geological Survey, and afterward went to Mexico and was employed on the Mexican National Railroad. J. W. Pethard, an Englishman, was formerly an officer in the English Navy, and has been connected with extensive engineering projects in India."

Railroad Accidents in Switzerland.—The Swiss railroad companies report for the year 1886, on 1,734 miles of railroad, 59 train accidents, 42 being derailments and 17 collisions. Of these collisions 10 were caused by misplaced switches or mistakes in signaling. Six derailments resulted from defects of rolling stock and 11 from misplaced or defective switches. The report shows an improvement over 1885, when there were 23 collisions and 63 derailments.